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SURVEY AND ANNOTATED BIBLIOGRAPHY ON
LITERATURE PERTAINING TO INTERNAL
FINANCIAL INCENTIVES IN
SYSTEM ACQUISITION

by

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Robert W. Blanning,
Paul R. Kleindorfer
Oreet Zohar

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Survey and Annotated Bibliography on Literature Pertaining to
Internal Financial Incentives in Systems Acquisition

R.W. Blanning, P.R. Kleindorfer, and O. Zohar

EXECUTIVE SUMMARY

→ This document is essentially a literature survey and it is motivated by on-going research on internal financial incentives in systems acquisition. The purpose of this research is to determine financial and non-financial consequences of internal incentives used in the acquisition of weapons systems. The research addresses itself only to the use of incentive systems within DOD (i.e., internal incentive systems), and not to contractual (i.e., external) incentive systems that operate between the Government and private contractors. Our basic approach is to study such incentives by considering the impact of various budgetary constraints over groups of projects at various levels in the Defense hierarchy and at various stages of the system acquisition process. A particular focus of attention is Design-to-Cost as an internal financial incentive. ←

From the above it is apparent that a broad range of literature is relevant to internal financial incentives. We have structured this literature into five areas of interest.

I. The literature on organizational design considers how organizations are structured and how they ought to be structured. The key design variables considered are authority structures, reward system, roles of information systems, and decision-making procedures.

II. Public sector decision-making has a broad literature dealing with bureaucracy, budgeting and, generally, with political processes.

III. A third area of concern is the rich set of normative models in economics and management science dealing with optimal (de-) centralization of resource allocation systems. Typically these theories specify iterative pricing and rationing policies for efficiently allocating a scarce resource among competing activities.

IV. An area of increasing concern and importance for management in general and systems acquisition in particular is that of incentives. This literature is concerned with situations where asymmetrical information or resource endowments and conflicting objectives require that incentives be

used, in lieu of direct orders, to obtain results. This is clearly the situation existing between, for example, government agencies and government contractors. It is also the typical situation existing between separate governmental agencies.

V. There have been a host of policy papers and commission studies in recent years on the systems acquisition process itself, and on Design-to-Cost as it relates to this overall process. These are reviewed in the final section of the bibliography.

Each of the five sections noted above will summarize pertinent research issues at the beginning and end of the respective sections. In addition, the Conclusions section of this report will synthesize our views of the main research questions suggested by this survey for internal financial incentives. In brief, we find the most promising areas of research to be normative and empirical studies related to the coordination of risk, incentives, and information in multi-level organizations. Concretely, this suggests that detailed field studies should be undertaken on actual organization and allocative effects of currently used internal incentive mechanisms such as Design-to-Cost.

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INTRODUCTION

A. INCENTIVES AND SYSTEMS ACQUISITION

Planning and control of defense expenditures remains one of the most fascinating research areas of public finance, economics and management. The interest of this area stems both from its intrinsic importance as well as from the magnitude of the problems involved. The survey and bibliography which follow are intended as a structured introduction to major contributions in the varied academic and institutional literatures on defense expenditures. The scope of any such survey is perforce limited, of course. Our purpose in performing this survey is to provide background material and a research perspective for our on-going research on internal financial incentives in systems acquisition. Thus, before describing the structure of the annotated bibliography which follows, it will be useful to recall the general nature of the research project (hereafter referred to simply as the "Project") which gave rise to this survey.

An important motivation for implementing financial incentives in Naval (and other defense) systems acquisition is the growing cost of weapons systems and the ongoing and anticipated decline of real dollars available for the design, development, and production of these systems. The defense and defense-related literature is replete with summary statistics and individual examples of cost growth in weapons systems. A recent GAO study* suggests that "revisions to specifications" accounts for a major part of this growth and that inflation and inaccurate initial estimates are significant contributing factors.

An alternative, but not contradictory, way of viewing the problem of cost growth is that there are insufficient incentives for DOD, the military services, and defense contractors to reduce the costs of acquiring major weapons systems. Certainly, all of the participants in the acquisition process would like to keep their costs within reasonable limits, but all

* "Cost Growth in Major Weapons Systems". Report to the Committee on Armed Services, House of Representatives, by the Comptroller General of the United States, B-163058, March 26, 1973. See especially, pp. 24-31.

too often cost increases are "passed through" from the contractors, through the military services, through DOD, to the Congress. Although a substantial literature has been devoted to contractor incentives,* little attention has been paid to the possibility of designing formal financial incentive systems within DOD and the military services.

B. OVERVIEW OF THE SYSTEMS ACQUISITION PROCESS

In order to understand more completely the systems acquisition process and the possible use of formal financial incentives in managing the process, let us first structure this process more concretely and then turn to contractual and other measures used in planning and control of the acquisition process.

There are four stages in the acquisition of a weapon system. Starting from basic research, the following stages are concept formulation, validation, and finally full scale development and production. During the concept formulation stage, preliminary designs are readied and a Decision Coordinating Paper is prepared by the Office of the Secretary of Defense which sets review thresholds for costs, schedules and technical performance.

Contractor proposals are solicited and evaluated during the validation stage of the acquisition cycle and the system must be approved by the Secretary of Defense before proceeding to the Development stage.

Prototypes are developed, produced and tested during the Development phase. Production is then subject to approval by the Secretary of Defense and authorization and funding by Congress. However, it has become customary to initiate the production phase of the acquisition process before the development phase has been completed. Arguments made by the Department of Defense and contractor personnel in support of this concurrency are: (1) The need of the weapon is urgent and thus precludes

* For a recent review of this topic, see Arming America: How the U.S. Buys Weapons, by J. Ronald Fox, Division of Research, Graduate School of Business Administration, Harvard University, Boston, 1974, especially, pages 240-240.

testing time; (2) Required materials and components required for production require long ordering lead time or long manufacturing cycles and must be ordered early to prevent time lags; (3) Since the development contractor is usually awarded the production contract, many company personnel are already at work on both phases.

There are at least six levels of management between a Program Manager and the Secretary of Defense, each of which must ultimately approve the project. This upward filtering process in which each officer along the tier makes minor adjustments to assure approval by the next tier, may result in an increasingly optimistic (in terms of both cost and performance) program report finally arriving at the Secretary's desk.*

If the above makes intragovernmental coordination of projects seem complicated, the situation is certainly no better between governmental agencies and private contractors.

There are two general types of contracts in Government procurement, cost reimbursement and fixed price. The Armed Services Procurement Regulation provides for four basic types of cost reimbursement contracts: (1) cost plus fixed fee, (2) cost reimbursement without fee, (3) cost sharing, (4) cost plus incentive fee.

Before a fixed price contract is awarded, the Government and the contractor negotiate on the following elements: (1) target cost, (2) target profit (which is the negotiated profit for work performed at target cost), (3) ceiling price (which is the total dollar amount for which the Government will be liable), (4) sharing formula (the arrangement for government and contractor cost sharing below the ceiling price).

During the 1960's, incentive contracts were used to provide contractors with incentives lacking in cost reimbursement contracts. These incentive contracts were intended as a means of controlling procurement costs, communicating the Government's objectives and motivating the contractor's management to achieve them.** By reducing the total profit as

* See the discussion of bureaucratic aspects of the weapons acquisition process in Fox [1973], Arming America, op. cit.

** U. S. Department of Defense and NASA Incentive Contracting Guide, (Washington: Government Printing Office, 1969).

actual costs are reduced below target, the contracts were supposed to encourage contractors to achieve cost underruns. However, Irving Fisher has presented empirical evidence which suggests that incentive contracts have not achieved their intended goals.* In fact the system may have backfired in the sense that defense industry groups tried to convince the Defense Department to revise its budgeting system so that the contract budget levels will be established at the ceiling price, rather than the lower target price.

A 1970 Rand study from 1970 on 94 Air Force contracts concluded that contract cost growth was not influenced by type of contract.** A 1971 study by the Army Procurement Research Office of 200 Army incentive contracts concurred with the Rand studies.***

Some industry executives have expressed the fear that earning profits higher than negotiated target profits would embarrass their Government Contracting Officers, causing them to negotiate lowered costs on subsequent contracts.

In the early 60's, Robert Charles, then Assistant Secretary of the Air Force, designed Total Package Procurement. Under this system, contractors were asked at the beginning to bid on a total program package consisting of the development, production, and spare part support work. The plan was hoped to counter the "underestimated cost" problem in which contractors would intentionally bid low in order to win a contract and place themselves in a sole source position for the follow-on production contracts where they could subsequently recoup their losses. By 1972, after the C-5A difficulties, Total Package Procurement was abolished by the Deputy Secretary of Defense. Fox [1973] (in Arming America) claims that most

* Irving N. Fisher. "A Reappraisal of Incentive Contracting Experience," RM 5700 PR, June 1968.

** "A Preliminary Analysis of Contractual Outcomes for 94 AFSC Contracts". Rand WN 7117, December 1970.

*** Army Procurement Office, "An Analysis of 200 Army Incentive Contracts," Fort Lee, Virginia, March 1971.

senior Pentagon officials have concluded that there do not appear to be any contractual mechanisms that could incentivize internal cost controls.

In the early 60's, Charles Hitch, then assistant Secretary of Defense, attempted to implement Planning Programming and Budgeting (PPBS). Budgets were approved for specific weapons systems rather than for a total procurement effort. However since no uniform methods of financial control were implemented, a morass of different cost control systems had developed by 1965. Not infrequently, contractors were confronted with information requirements from the Defense Department that were not compatible with their internal control systems.

In 1962, Peck and Scherer concluded that lack of timely decision making appeared to be a contributing cause to inadequate program cost controls. "Decision making takes on particular importance if one accepts the hypothesis that scientists and engineers could tend to continue exploring interesting technical problems indefinitely were it not for management's decisions to stop searching for better answers and begin finalizing hardware designs."*

In 1970, the Blue Ribbon Panel identified the same problem of delayed decision making. "In vertical organization, the management system maze and the extensive reporting requirements often result in an extensively large staff for a program manager, adding significantly to the overall management cost of the project."** The Government Accounting Office, in a 1971 study, also found the extensive layering to severely handicap the decision-making function.

Given these difficulties and the increasing social pressures on the Defense Budget, it is not surprising that more stringent cost control methods were entertained. Design-to-cost, one of the major foci of our interest in internal financial incentives, appears to have resulted from this concern.

* Peck and Scherer [1962], p263-264.

** Report by the Blue Ribbon Panel to the President and secretary of Defense on the Department of Defense, July 1, 1970.

The U.S. General Accounting Office defines design-to-cost as a system for establishing unit cost goals for the production of a large number of weapon systems. The system is viewed primarily as a cost control device, and not as an internal or external financial incentive system. This definition is sufficiently vague so as to entertain a number of widely varying interpretations. For example, Robert Bidwell, Director of Defense Product Engineering Office, suggests in the June 1974 issue of Defense Management Journal that the general logic of design-to-cost is that cost goals as well as performance parameters will be progressively refined and stabilized as the program moves through conceptual, validation and full scale development phases. The goals will thus be reviewed at each major stage and adjusted if necessary until a full design-to-cost goal is achieved by the time full scale development is initiated.

C. INTERNAL FINANCIAL INCENTIVES

This bibliography is part of a larger project whose purpose is to examine the advantages and disadvantages of using internal (within DOD and USN) financial incentive systems, such as design-to-cost, in weapons systems acquisition. The purpose of such incentive systems is to provide defense officials and military officers at the various levels of the DOD/USN hierarchy with formal incentives to maintain effective controls over the costs of weapon systems. Although the incentive systems will be based on cost control, the evaluation will also take into account the time at which they become available for use and their performance.

Before proceeding, it is worthwhile to consider the differences between internal and external incentives in systems acquisition. The rationale for external or contractual incentives is to motivate private contractors to act in consonance with DOD or Service objectives. Because of the clear two-party distinction between contractors and Government agencies, legal issues relating to contract management and anti-trust law are paramount in the design of external incentive systems. Internal incentives are incentives addressed to participants and agencies within the Defense hierarchy of the Government. Our basic approach is to study such incentives by considering the impact of various budgetary constraints over groups of projects at various levels in the Defense hierarchy and at various stages of the system acquisition process.

The use of internal financial incentive systems is, of course, not restricted to the public sector, and some data and research on such systems is available. During the past 50 years industrial organizations in the U. S. and other western nations have developed and implemented decentralized systems for "profit center" management in which divisional managers are encouraged to acquire new facilities and to operate existing facilities in ways that best meet the objectives of the corporation as a whole.* Similarly, most of the socialist nations of East Europe and the Soviet Union have begun to implement "economic reforms" and "new economic systems" in an attempt to provide middle-level managers with formal incentives to increase the efficiency of production and distribution by encouraging more efficient acquisition and utilization of equipment and personnel.** Both of these systems are internal systems - that is, they provide financial incentives to managers in a single organizational hierarchy, such as an industrial corporation or a socialist government.

D. OUTLINE OF BIBLIOGRAPHY

Given the above general research perspective, the literature related to internal financial incentives in systems acquisition has been structured into the following major areas for purposes of the annotated bibliography which follows.

I. Organizational Design. This includes descriptive and normative theories of organizational design, primarily from the perspective of the private sector.

II. Public Sector Decision-Making. This is concerned with organizational and informational aspects of decision-making from the public and non-profit perspective. A primary aspect of this area is budgeting in

* See for example P.R. Kleindorfer and M. R. Sertel, "An Exploration in Optimal Enterprise Design via Incentives," International Institute of Management, West Berlin, January, 1976.

** See for example Robert W. Blanning, Andrzej W. Kisiel, and Myron Uretsky, "The New Economic System in Poland," Columbia Journal of World Business, Winter 1973, pp. 113-119.

the public sector.

III. Decentralization of Resource Allocation Systems. This literature covers the various management, economic and mathematical theories relevant to optimal (de-) centralization. The primary concern here is with pricing, rationing, and informational mechanisms for allocating scarce resources across competing activities.

IV. Incentives. This area covers the theoretical literature on incentives. The major focus here is on situations where an authority structure is assumed, but where asymmetric access to information and resources requires that the "boss" achieve desired results not by fiat, but primarily through incentives. The associated issues of monitoring (e.g., the effectiveness of incentives) are also reviewed.

V. Institutional and Design-to-Cost literature. There have been a host of studies by government commissions and agencies over the past decade on systems acquisition. These and especially internal documents related to systems acquisition philosophy and procedures are reviewed in the fifth section of the bibliography.

We will devote a separate section in the bibliography to each of the above topics. Each section will summarize the major implications of the literature reviewed as related to the Project. These implications will also be integrated across areas in the Conclusions section of this report, immediately following the entire annotated bibliography.

I. ORGANIZATIONAL DESIGN

The literature on organizational design describes the ways in which organizations respond to the limitations of its members in processing and making effective use of information. The four documents described below examine three such responses. The first response is to change the way in which the organization maintains resources, assigns tasks, and develops channels of inter-personal communication. That is, the organization changes its structure. This is described in the book and the article by Jay Galbraith below and in the book by Lawrence and Lorsch. The second response is to change the way in which decisions are made and information is processed. Organizations often limit the range of alternatives considered in decision making and restrict the types of information acquired in response to the behavioral limitations outlined above. This is discussed in the book by Braybrook and Lindbloom below. The third response is to acquire external facilities and operations - that is, to bring into the organization personnel and facilities previously maintained in the environment. This is discussed in the article by Williamson.

Designing Complex Organizations, by Jay Galbraith, Addison Wesley, Reading, Massachusetts, 1973. This book suggests that a major problem in large organizations is the processing of information for planning and control. It further suggests that organization design strategies are in large measure intended either to reduce the flow of information to reasonable levels or to increase the capacity of the organization to process information. That is, organization design strategies derive from two sources. The first source is "information reduction strategies". Galbraith identifies two such strategies: creation of slack resources and creation of self-contained tasks. The second source increases information processing capacity, and it consists of two strategies: investment in vertical information systems and creation of lateral relations.

The first of the four strategies, creation of slack resources, consists of such sub-strategies as acquisition of additional personnel, acquisition of additional capacity for materials processing, and acquisition of raw materials in excess of those needed for production. As Galbraith points out, an organization may use this strategy "not because of poor management but because it does not have the information processing and computational capacity to deal with the coordination requirements of interdependence."

The second strategy, creation of self-contained tasks, consists of partitioning common resources among autonomous or weakly dependent groups. This usually results in a reduction in division of labor and a decrease in the need for coordination between the inputs and outputs of an organization across divisions. Galbraith points out that strategy has been widely used in geographically and functionally diverse organizations, such as Dupont, Sears Roebuck, and many state university systems and aerospace firms.

The third strategy, investment in a vertical information system, is a form of selective decentralization. During the planning cycle of a project or an ongoing organizational effort attempts are made to identify in advance any problems that may arise during implementation and to specify the appropriate level in the hierarchy for solving each of these problems. This will increase the effort needed to prepare plans, but it is intended to decrease the effort needed to implement the plans by limiting the information flows needed to correct deviations from plan. Galbraith gives an example of this strategy in a medical clinic.

The fourth strategy, creation of lateral relations, is similar to the third strategy in that it results in a decentralization of decision making. However, the decentralization is even more complete. This strategy includes such sub-strategies as establishing direct contact between managers with similar problems, creating temporary task forces to solve common problems, and creating the dual authority relations of a matrix organization. Galbraith identifies seven types of lateral relations and suggests that organizations should create formal mechanisms to encourage and require lateral communications where it is appropriate.

This book is relevant to our study because a formal financial incentive system may be considered yet another information reduction strategy. That is, Galbraith correctly identifies information processing as a major problem for large organizations, and he focuses on organization design and redesign as a method of mitigating this problem. Financial incentives and Galbraith's four strategies are separate but not exclusive approaches to coping with information processing problems - that is, they may be used in combination. It is not clear at present what the appropriate combination is.

A Strategy of Decision: Policy Evaluation as a Social Process, by David Braybrooke and Charles E. Lindblom, The Free Press, New York, 1963. This book is the first major work to point out that budgeting in government agencies is usually conducted not on a rational comprehensive basis (i.e., by means of a thorough evaluation of alternatives), but by an incremental strategy in which budget preparation and justification focuses on deviations from budgeted or actual expenditures of the previous year. This book differs from the largely empirical research in this area in that it attempts to explain and justify incrementalism on a priori grounds. Much of this is supported in the later articles and books by Aaron Wildavsky, who has documented the existence of incremental budgeting practices, especially in the Congress and the Department of Agriculture.

The authors begin by explaining problems in public planning that give rise to a need for incrementalism. These problems are as follows: (1) man's limited intellectual capacities, (2) his limited knowledge, (3) the costliness of analysis, (4) the analyst's inevitable failure to construct a complete rational deductive system or welfare function, (5) interdependencies between fact and value, (6) the openness of the systems to be analyzed, (7) the analyst's need for strategic sequences to guide analysis and evaluation, and (8) the diversity of forms in which policy problems actually arise. Thus the authors examine in detail the way in which the government planning and budgeting is hindered by problems of information processing. This is of special interest to us because (1) formal financial incentive systems may be an alternative (to

incrementalism) method of mitigating these information processing problems and (2) these problems may hinder the implementation of an incentive system.

The authors then describe in detail how incrementalism, and especially incremental budgeting, appears in government organizations. This includes deliberate limitations on budget analysis, a failure to separate forcefully the objectives of a program and the means of accomplishing those objectives, a serial or sequential (rather than simultaneous) evaluation of alternatives, a remedial approach to decision making which attempts to resolve problems rather than to seize opportunities, and a "reconstructive", or narrow, focus on data generation. The authors summarize this strategy by stating "The analyst makes an incremental move in the desired direction without taking upon himself the difficulties of finding a solution. He disregards many other possible moves because they are too costly (in time, energy, or money) to examine. For the move he makes he does not trouble to find out (again, because it is too costly to do so) what all its consequences are. If his move fails or is attended by unanticipated adverse consequences, he assumes that someone's (perhaps even his own) next move will take care of the resulting problem" (p.53). Thus, the authors regard incrementalism not as a wasteful bureaucratic strategy, but rather as a necessary adaptive response to problems of information processing in large public-sector organizations. As suggested above, we may wish to determine the relationships between financial incentive systems and incrementalism as responses to difficulties in organizational information processing.

"Markets and Hierarchies: Some Elementary Considerations", by Oliver E. Williamson, Organizational Forms and Internal Efficiency, Vol. 63, No. 2, May 1973. The purpose of this paper, as stated in the introduction, is to "examine the factors which induce a shift of transactions from market to internal organization and, within internal organization, to explain the type of hierarchical relations that predictably emerge." Williamson refers to this shift as a "market failure" and suggests that there are two sets of factors that account for the failure. The first are human factors which

consist of (1) bounded rationality, which "refers to rate and storage limits on the capacities of individuals to receive, store, retrieve, and process information without error," (2) opportunism, which Williamson defines as "an effort to realize individual gains through a lack of candor or honesty in transactions," and (3) atmosphere, which Williamson defines as organizational modes and practices which may enhance productivity. The second set of factors that influence market failures are transactional factors, which consist of (1) uncertainty, (2) small numbers of traders, resulting in a heterogeneous market, and (3) information impactedness, in which "one of the agents to a contract has deeper knowledge than does the other" and "it is also costly for the party with less information to achieve information parity." Williamson feels that the latter factor is especially important, and that "internal organization may be favored instead [of markets] because it affords economies of communication."

With regard to internal organization, Williamson focuses on "the shift from peer group to simple hierarchies, for bounded rationality and experience rating reasons, and thence to multi-staged hierarchies, for transactional reasons." Williamson examines several advantages and limitations of both peer-group associations and simple hierarchies in terms of the factors mentioned above and briefly examines how these factors may also result in the coordination of functional departments.

"Organization Design: An Information Processing View", by Jay R. Galbraith, Interfaces, Vol. 4, No. 3, May 1974. Galbraith's principal point is that "the greater the uncertainty of the task, the greater the amount of information that has to be processed between decision makers during the execution of the task," and that "observed variations in organizational forms are variations in the strategies of organizations to (1) increase their ability to preplan, (2) increase their flexibility to adapt to their inability to preplan, or (3) to decrease the level of performance required for continued viability." Galbraith feels that the criterion for selecting a strategy is its cost relative to other strategies, and the purpose of this article is to examine these strategies in more detail and to describe the appropriate costs.

Galbraith assumes that the selection of a design takes place in an organization that "is large and employs a number of specialist groups and resources in providing the output" and that "after the task has been divided into specialist sub-tasks, the problem is to integrate the sub-tasks round the completion of the global tasks." The purpose of an organization design is, in Galbraith's view, to facilitate this process of decomposition and integration.

Galbraith identifies four organization design strategies, the first two of which reduce the need for information processing, and the second two of which increase the capacity of the organization to process information. The four strategies are (1) creation of slack resources, (2) creation of self-contained tasks, (3) investment in vertical information systems, and (4) creation of lateral relations. The description of the strategies is similar to the description that appears in Galbraith's book, Designing Complex Organizations. Galbraith feels that these strategies are primarily an adaptive reaction to uncertainty, that "the organization must adopt at least one of the four strategies when faced with greater uncertainty," and that a failure to choose one of the strategies will result in reduced performance. Finally, he suggests that an organization might implement a fifth strategy, operating on the environment to reduce uncertainty (for example, by means of long term contracts, coalitions, etc.), but he does not examine these in any detail.

"Developing Organizations: Diagnosis and Action" by Paul R. Lawrence and Jay W. Lorsch, Addison-Wesley, Reading, Mass., 1969. This book is one of a series published by Addison-Wesley on Organization Development. The authors define organization development as an activity whose purpose is "to change the organization from its current state to a better-developed state," and they point out that their book derives largely from their consulting and research experience and not from a comprehensive synthesis of the literature. They define an organization as "the coordination of different activities of individual contributors to carry out planned transactions with the environment." Thus, the book places a major emphasis on the interaction between an organization and its environment, and it then

analyzes the interactions that take place between individuals and groups within the organization.

In an early chapter, the authors examine three sets of concepts on which they base their analyses. The first of these are two concepts from systems analysis: the interdependence between organizational elements and the morphogenic property of organizations. Interdependence is important in organization development because an attempt to change one part of an organization may have an impact on some or all of the other parts, and this must be taken into account in attempting to bring about organizational change. The morphogenic property of organizations, by which is meant their "ability to modify themselves in basic structural ways," is important because this property increases an organization's ability to cope with its environment.

The second set of concepts are those of differentiation and integration. The authors state that the degree of differentiation of an organization "depends upon what internal characteristics each group must develop to carry its planned transactions with its assigned part of the environment," and "depends primarily upon the extent to which the certainty of information within the various parts of the environment is similar or different." Integration among the units of a highly differentiated organization may be accomplished by establishing and enforcing a hierarchical organization structure or by means of such "supplemental integrating devices" as individuals and teams whose purpose it is to provide interfaces between the established units of an organization.

The third set of concepts consists of four stages to organizational development that the authors have found useful in their research and consulting experience. The first is a descriptive diagnosis of the current state of the organization, which is an examination of the degree of differentiation and integration of the organization and any resulting organizational conflicts. In the second stage, action planning, individuals in the organization who might be "motivated to make a change attempt" are identified, and appropriate action interventions are specified. The third stage, implementation, "translates the selected plan into actual behavior," and is accomplished by scheduling the implementation process and by monitoring the progress of the implementation effort. The fourth stage, evaluation, consists of "comparing planned goals with actual

results and diagnosing the variant and its causes." This final stage may initiate a new organization development cycle.

In the remainder of the book, the authors apply these concepts to three sets of boundaries found in organization. The first is the interface between the organization and its environment, the second is the interface between groups within the organization, and the third is the interface between the individuals of the organization and the organization itself. In the first case, the authors are concerned with the correction of mismatches between an organization and its environment caused by the structure of the organization or by changes in the environment. In the second case, the authors are concerned with providing the proper level of integration for a differentiated organization either by operating within the existing organizational structure or by changing the structure. In the third case, the authors are concerned with the ways in which individuals can be motivated to conform to organizational goals, especially when the individuals have no equity ownership in the organization. Unfortunately, the authors do not present strategies for mitigating or overcoming these problems, rather, they give examples of organizations that have grappled with these problems. In many instances, they illustrate the use of the four stages of organizational development identified above.

This book is relevant to our project because it identifies ways in which the need for organizational change may be identified and the changes implemented. Thus, the four-stage process of organization development presented in the book may be useful in implementing a financial incentive system as well, and the examples given in the book may suggest useful strategies for implementing such a system.

CONCLUSION

The books and articles described above are relevant to internal financial incentives in the following way. The establishment and implementation of an internal system may be viewed as yet another response to behavioral limitations on information acquisition and processing. In this context, one may suggest that there are four principal methods of responding to information processing limitations: (1) modifying the organizational structure, (2) modifying the decision process (to produce an incremental planning and budgeting system, (3) organizational acquisition of environmental operations, and (4) the establishment of a formal financial incentive system. This suggests that it is important to examine the interactions between internal financial incentives and the other three responses to information processing limitations. For example, it is necessary to understand the advantages and disadvantages of an internal financial incentive system relative to the other three types of organizational response outlined above. It is also necessary to understand the extent to which a formal financial incentive system helps to solve problems for which the other three responses are inappropriate.

II. PUBLIC SECTOR DECISION-MAKING

This section of the bibliography on Public Sector Decision making is divided into three areas, bureaucratic behavior, implementation analysis and the the management and control of organizations.

Political Science has only recently begun to address the questions of bureaucratic behavior and the motivations and incentives of the various actors and tiers within the hierarchy.

Part of the problem with numerous previous attempts to monitor and control federal programs lay in the fact that sufficient weight had not been assigned to the bureaucratic structure, both formal and informal, (informal being structures that are not formally recognized in the organization chart). Anthony Downs book, Inside Bureaucracy is regarded as a classic as a categorical identification of tiers and classes of individuals at different phases in the hierarchy and the identification of the differing personal incentives to which each is subject. Simon, Niskanen and Kaufman are also forerunners in this area. Simon was one of the earliest to detail a descriptive analysis of inducement and incentives in a bureaucracy. Niskanen attempts to design an economic model of bureaucracy in order to facilitate the understanding of its functions. Kaufman and Wilson both deal with the question of organizational change. Kaufman addresses the critical question of organizational adaptability and tests empirically the "reaction function" of organizations when confronted with changing environments which place differing demands on the organization.

A fairly new arena in Political Science, Implementation Analysis, was born out of the failures of the Great Society era. Political Science case studies such as Graham Allison's on the Cuban Missile Crisis and Irving Janis on group think had focused on systemic malfunctions in political processes. The new breed of political scientist, (Wildavsky, Pressman, Levine, Hargrove) start where previous studies concluded. They start from desired end goals and trace the implementation of programs designed to accomplish these goals through the entire bureaucracy. Their purpose is to identify the actual points where such initially set desired end goals

were adapted, adjusted or somehow just altered. This literature on implementation analysis is thus closely related to the organizational design literature, and especially the work of Braybrook and Lindbloom, (reviewed in Section 1 of this bibliography.)

A third section of public sector decision making dealt with here relates to the issue of organizations and services. Hirshman and Titmuss address questions regarding the quality of service in organizations where competitive sanctions do not necessarily operate. Anthony and Herzlinger focus specifically on management and control problems in non-profit organizations.

William Niskanen, Bureaucracy Servant or Master, Institute for Advanced Economics, Westminster, England, 1973. Niskanen in this book attempts to develop an economic model of bureaucracy. He defines a bureau as a non-profit organization (which may be governmental or private) that is financed, wholly or partly by a periodic grant. He attributes three characteristics to bureaucracies: Their owners and employees do not appropriate any part of the difference between revenues and costs as personal income; Some part of the recurring revenues are derived from other than the sale of output at a per unit rate; bureaus specialize in providing goods and services in larger amounts than would be supplied by the sale of their output at a per unit rate.

Niskanen goes on to examine the power of a bureau, as both a competitor and a monopoly, its product, the incentives and motives of bureaucrats, and the relationship between the bureau and its sponsoring organization. He defines the relationship between a bureau and its sponsor as that of a bilateral monopoly, i.e. a seller with no alternative consumer confronted by a consumer with no alternative supplier.

Niskanen argues that bureaus have a comparative advantage in the supply of services for which it is difficult to define (and consequently contract for) output as well as during "crisis" periods when objectives are more clearly consistent throughout government. He subsequently suggests that an improvement in contracting or monitoring procedures would increase

the opportunity for use of profit seeking organizations to fulfill functions now filled by bureaus.

Niskanen's main finding is that bureaucracies tend to be too large. This leads to his discussion of three methods to correct for excess size which are: Reconstruction of internal working by competition or by quasi-profit incentives to bureaucrats in order to maximize the surplus of budgets over costs; Development of market alternatives to government agencies; and political reorganization to make bureaucracies more sensitive to public opinion.

Herbert Kaufman, The Limit of Organizational Change, University of Alabama Press (1971), In this book, Kaufman starts from the theoretical assumption that organizations, once formed should be able to modify themselves structurally and behaviorally as a "swiftly changing environment requires" and thus continue indefinitely once they have been started. Kaufman goes on to examine the barriers to organizational change and cases where failure to change the behavior and/or structure of an organization can be fatal to it. He groups these factors into three broad categories: acknowledged collective benefits of stability, calculated opposition to change, and inability to change. Kaufman concludes his study in support of evolutionary changes for organizations rather than revolutionary changes. This concurs with the work of Braebrook and Lindblom discussed in Section I of this bibliography.

Herbert Kaufman, Are Government Organizations Immortal? (Brookings 1976). In Are Government Organizations Immortal Kaufman empirically tests some of the points he brought up in the Limits of Organizational Change. He tests more than 400 units of federal executive departments and concludes in support of the widespread impression that agencies stay alive once they have been formed. A fact that Kaufman uncovers in this study is that both the formation and dissolution of government organizations occur in spurts.

Even in cases where organizations folded, the functions and activities performed by the agencies were not in most cases terminated. They were generally reassigned or taken up by other units. Recognition of this fact that functions and activities can often supersede even the organization itself bears some import for our study. In particular, functions which become increasingly cumbersome or even counterproductive may be discontinued unless a positive action is taken to dissolve the function.

Herbert Kaufman, Administrative Feedback Monitoring Subordinate Behavior (Brookings 1973). In Administrative Feedback, Kaufman starts from the premise that people usually have to be pushed quite far before they resort to overt disobedience, strikes, or revolution. Generally, when orders from above conflict sharply with their values, individuals quietly construe the orders in a way that makes them tolerable. In this way organization policies may be amended at lower administrative levels. (A Cognitive Dissonance Argument)

Kaufman notes that virtually all commentators on democracy take for granted the essential contribution of leadership and that subordinate compliance is regarded as a pillar of democratic government. He believes that the ability to elicit obedience depends not only on sanctions, but on the employee's sense of legitimacy, of identification, and of confidence (which he defines as the feeling that another person knows more).

The third part of the book explores the problem of the social sources of discipline in administrative structures. The problem is to set up the administrative structure such that rational decisions are actually enforced in day to day action, given the fact that employees are paid a salary, rather than directly collecting the benefits of their rationality.

The relevance of this study to our project lies in the fact that to employ sanctions effectively leaders must know what their subordinates are doing, for they may reward and punish the wrong subordinates, or the wrong behavior if they are inadequately informed, and may thus encourage disobedience instead of compliance. The correct application of sanctions and incentives are thus dependent on appropriate feedback mechanisms.

Herbert A. Simon, "Inducements and Incentives in Bureaucracy" in Administrative Behavior The MacMillen Co., 1945. In this paper Simon discusses the various types of incentives to which employees are subject to within a bureaucracy, and how their consequent behavior affects the organization. Simon describes three characteristic sets of inducements: personal rewards deriving directly from the accomplishment of the organization objectives; personal inducements offered by the organization and closely related to its size and growth which he defines as conservation values; and personal rewards derived from inducements offered by the organization but unrelated to the organization size and growth.

In a non-volunteer organization the most obvious personal incentive that an organization can offer is money. Simon points out that "It is a peculiar and important characteristic of his relationship with the organization that in return for this inducement, (an employee) offers the organization not a specific service but his undifferentiated time."

Simon suggests that the individual who is loyal to the objectives of the organization will resist modification of those objectives whereas the individual who is loyal to the organization will support opportunistic changes in its objectives that are calculated to promote its survival and growth.

The dynamics of the organization are such that the contributions of one set of members of the organization serve as inducements to another set. Simon describes the organization as being in equilibrium if the sum of the contributions is sufficient, in quantity and kind, to supply the necessary quantity and kinds of inducements.

James Q. Wilson, "Innovation in Organization: Notes Toward A Theory" in James D. Thompson, ed., Approaches to Organizational Design, Pittsburgh, University of Pittsburgh Press, 1966. Wilson starts from the conception that the central analytic attribute of any organization is its "economy of incentives." He defines an incentive as any gratification,

tangible or intangible, in exchange for which persons become members of the organization and once in the organization contribute time, effort, or other valued resources. Wilson argues that regardless of the purpose, product or technology of the organization this inducement contribution balance must be maintained for the organization to function efficiently.

Wilson assumes that each person in the organization is performing a task (a task is defined as all those activities that add up to the full time in the organization of one member). He assumes that all members in the organization endeavor to act rationally, but that no two members necessarily have exactly the same preference orderings. What is a cost to one member, (e.g. the need to spend much time in conferences) may be a benefit to another. An innovation is defined as a fundamental change in a significant number of tasks.

Wilson assumes that each organization can rank proposed changes in terms of how radical an impact they will have on the inducements - contributions balance. The greater the cost in scarce inducements, the more radical the innovation regardless of the prospective benefits.

Incentives are defined to include such things as; money, prestige, status, the power of office, opportunities for rewarding social relationships, and organizational purposes. The cost of an innovation is thus the extent to which any of these incentives must be redistributed or their supply decreased. Since the members of large organizations differ in both their personal preference for incentives and their taste for risk, it is impossible to say that under a specific set of circumstances any single organization or any class of organizations will respond in a particular way.

Anthony Downs, Inside Bureaucracy, Boston, Little Brown and Co., 1967. In Inside Bureaucracy, which is a classic model of bureaucratic behavior, Downs sets up a series of laws and postulates of bureaucratic functioning. Downs goes into detailed descriptions of: bureaucracy life cycles; internal characteristics of bureaucracies; motivations and behavior of the different types of bureaucratic officials; communication within and

between bureaus; control processes, devices and problems; information transfer and search problems; bureaucratic change processes; territoriality; bureaucratic ideology, goal consensus recruitment and indoctrination.

Of interest to our projects is the chapter on "How Ignorance Affects the Government Budgeting Process" where Downs describes the necessity for incremental budgeting.

Fritz W. Scharpf, "Does Organization Matter? Task Structure and Interaction in the Ministerial Bureaucracy", Berlin, International Institute of Management, February, 1976. Scharpf discusses some of the theoretical and methodological problems associated with a reorganization study of the Federal Ministry of Transport in West Germany. This paper is relevant to our project in that it is a pioneer as a theory oriented, systematic analysis of a bureaucracy.

Scharpf develops what he calls a "task impact analysis". He constructs a matrix which relates the policy tasks of different sectors within the ministry to a predefined set of impact areas. Interactions between the ministry and its environment are described by a complex network of symmetrical and asymmetrical exchange relationships. Both hierarchical cluster analysis and factor analysis are employed to analyze the structural patterns represented in the similarity matrix. An independent interaction analysis was also conducted for use as a check on the results arrived at via the task impact analysis. Scharpf's results suggest that organizational boundaries seem to create semipermeable walls which impede the flow of information and consequently induce the capacity for conflict resolution. What may perhaps be most interesting in light of our study is the fact that Scharpf was able to provide valuable recommendations for increased ministerial efficiency while operating within the constraint of taking the personnel system as given.

Erwin C. Hargrove, The Missing Link The Study of the Implementation of Social Policy (The Urban Institute, Wash., D. C. July 1975). This paper is a general overview of implementation analysis and where and how it fits into and ties together the traditional disciplines of Political Science, Public Administration and Economics to provide viable public policy.

Hargrove focuses upon increasing the understanding of institutional behavior via development of analysis and research on implementation. He criticizes both cost-benefit analysis and PPBS on the grounds that they are not sensitive to the dimension of implementation. Hargrove stresses that evaluation is not the same thing as implementation because evaluation usually concentrates on ultimate program impact without questioning institutional means.

Hargrove as well as Pressman and Wildavsky endorse the concept of implementation estimates, which entails a revision of ends or goals according to availability of means. The critical point here is that an estimate of implementation difficulties can therefore shape policy decisions.

The key question Hargrove attempts to address is "What kinds of knowledge are required to be able to predict the consequences of organizing the delivery of a social program in one way rather than another?"

Hargrove emphasizes, as do most studies of this type the intergovernmental conflicts of the different priorities and incentives which motivate federal, state and local interpretations and activity. However, his approach to bureaucratic analysis can well be incorporated into a study of internal financial incentives and the institutional effects of weapons acquisition.

Robert A. Levine, Public Planning: Failure and Redirection, New York, Basic Books, 1972. The focus of the book is to analyze planning failures. Levine examines empirically the gap between expectations and achievements in order to analyze its causes, and to suggest ways of narrowing it by improving achievements.

Levine argues that planning failures are a function of hierarchical misinterpretations. i.e., policy objectives are laid out by planners to be carried out by Administrators. The top layer sets out basic rules as general guidelines, the middle level then create detailed procedural rules leaving the operators at the bottom to apply the rules by interpretations based on administrative discretion.

In this process of sequential interpretation, the original policy or objectives more often than not get lost or even reversed. Levine's contention is that in order to advance policy objectives effectively, individual and organizational incentives should be used to interpret policies down to the operational levels, relying much less on rules than is now the case.

Levine claims that a major reason for the lack of direct applicability of detailed studies of bureaucracy and for the difficulty in getting a policy executed, is diffusion of decision making through large numbers of operating units. The key point that Levine makes is that bureaucratic chains are very sensitive to their weakest links.

Levine devotes a chapter to Military Policy and Planning. His emphasis is not so much on the financial issues as an actual policy planning and implementation. He does however stress the issue of multiple redundancies within the military system in an attempt to avoid "weak link" problems. He also brings up the fact that the incentive system within the military structure does not bring up many good planners within the services themselves.

"A truism among military planners is that the real enemy is not a foreign nation, but a friendly fellow service." Levine claims that since competition is not ordinarily considered to be a natural mode for bureaucracy, interservice rivalry is frowned upon (questionable), but that without such rivalry it seems likely that the military position of the U.S. would be much poorer than it is.

Jeffrey L. Pressman and Aaron Wildavsky, Implementation How Great Expectations in Washington Are Dashed in Oakland; Or Why Its Amazing that Federal Programs Worked at All, This Being A Saga of the Economic Development Administration as Told By Two Sympathetic Observers Who See to Build Morals on a Foundation of Revised Hopes, Berkeley, University of California Press, 1973.

The Authors show how the division of power in the American Political System poses severe challenges to even the most carefully thought out federal plans.

The relevance for our study is that Wildavsky makes the argument in favor of bureaucracy and against decentralization of components.

The costs of bureaucracy, a preference for procedure over purpose or seeking the lowest common denominator, may emerge in a different light when they are viewed as part of the price paid for predictability of agreement over time, among diverse participants. The price may be too high but the cost of accomplishing little or nothing otherwise must be placed against it claim the authors.

Charles Schultze, The Politics and Economy of Public Spending Brookings, 1968. Schultze examines the relation between the analytical and political approaches to budgetary decisions via an impact analysis of Planning, Programming and Budgeting (PPB) on civilian programs and how PPB can fit into the political process.

The section on incentives concentrates primarily on motivations in intergovernmental relations.

Schultze claims that failure of performance stems from two related causes: Negative failures, which fail to take account of private incentives that run counter to program objectives; and Positive failures, the failure to build into federal programs a positive set of incentives to channel the activities of decentralized administrators and program operators toward program objectives.

Albert O. Hirschman Exit Voice and Loyalty Responses to Decline in Firms, Organizations and States, Cambridge, Mass., Harvard University Press 1970. In Exit Voice and Loyalty, Hirschman examines the options of members of an organization to effect change. The book is quite broad based in that Hirschman tries to create a theory which is equally applicable to all organizations.

Hirschman discusses the conditions under which different classes of member consumers in organizations will employ different strategies. For example within the same organization, certain members may react to an unsatisfactory situation by voicing their disapproval and trying to actively change the status quo. Others may choose to simply exit from the organization and transfer their loyalties to another group which offers the desired services at a more desired quality. (In this particular case - it is of course assumed that the consumer has the option to exit and go elsewhere). Still other consumers may simply stay loyal to the organization.

Hirschman refutes the traditional assumptions of the schism between Economics and politics which assures that voice is primarily a political option and that exit is primarily a private sector economic option.

Hirschman's approach can shed a new light onto understanding the Dynamics of bureaucratic behavior and the available options for improving quality of service outputted.

Richard M. Titmuss, The Gift Relationship from Human Blood to Social Policy (New York: Vintage Books, 1972). The Gift Relationship is a comparative analysis of the organization of the supply and distribution of blood in the U. S. and Great Britain. The blood supply in Great Britain is totally voluntary whereas U. S. blood supply is a combination of volunteers and paid donors. Titmuss compares both the distribution mechanisms of the blood and the quality (measured by percentage contact of hepatitis) of the two societies.

His conclusion and main thesis of the book is that in this case the market system produces a lower quality product than the British all volunteer - altruistic system.

Titmuss goes on to suggest that this has broad ramifications for provision of all services. The relevance of this study to our work relates to incentival effects.

Titmuss' book along with Hirschman's Exit Voice and Loyalty are part of the growing body of literature which suggests non-market mechanisms can function more effectively than purely pecuniary or competitive systems.

Robert N. Anthony and Regina Herzlinger, Management and Control In Non Profit Organizations, Homewood, Illinois, Richard D. Irwin, Inc. 1975. This book is a study of management control in non-profit organizations. Its thesis is that the basic control concept are the same in both profit oriented and not-for-profit organizations.

Anthony makes the basic distinction between for profit and non-profit organizations based on organizational purpose. A profit oriented firm must render services that its customers find adequate if it is to earn a profit, whereas a non-profit organization derives its support from government revenues or other sources that are at least equal to its cost if it is to continue to render a service.

Anthony points out that generally a non-profit firm exists to provide a service rather than a product. Consequently much of the difficulty in exercising good management control in a non profit arises because of the difficulty in measuring quantity and quality of the services provided. Anthony also distinguishes among two types of non profits, client oriented and public oriented. A basic distinction between client oriented and public oriented institutions is that many public oriented organizations are unique. A client oriented organization has the management and control advantage that it can compare its costs or other data with similar organizations. Anthony points out however that the difference among service organizations as a class and production organizations as a class are probably greater than the difference between a non-profit and a

for-profit service organization. In light of the above argument, Anthony points out that there is a fairly widespread belief that research and development laboratories are not as well managed as production operations.

Many non profits can decide what services they should render according to their managers' best judgement, rather than according to market conditions. The effect of a non profit not needing to worry about competition has important implications for management control.

CONCLUSION

This section has considered the literature on public sector decision-making. We have focused our review on the following three areas; bureaucratic behavior, implementation analysis and management and control of Not For Profit organizations.

The main conclusions which emerge from this literature are the following: Incentives in bureaucracies are complicated to analyze because of the differing motivations that exist for different individuals in the hierarchy, as determined by their task and organizational environment. The budget is a major focus for incentives. The power and territoriality aspect of budgetary decisions is a critical aspect of bureaucratic behavior.

The above two arguments are further complicated when studied within a multi-level hierarchy. Implementation analysis attempts to deal with these dynamics and organizational problems to offer more efficient mechanisms to produce desired output from the bureaucracy.

Finally there is the whole issue of management and control of non-profit organizations. Because Public Sector programs are often unique, there does not exist a reasonable facsimile for cost comparison or comparison of performance output. Of primary concern to our project is the distinction that Anthony points out between a service output and a product output. Product outputs are of course much easier to monitor (both quality and quantity wise) than a service such as Research and Development. The weapons acquisition system currently treats these two aspects of Weapons provision (production and research) as simply parts of one lump package

with respect to monitoring and control.

III. DECENTRALIZATION IN RESOURCE ALLOCATION SYSTEMS

In the overview article "Decentralization in Organizations" annotated below, Peter Jennergren identifies four types of literature in this field. They are management theory, organization theory, quantitative approaches, and accounting theory. Most of the articles described below are relevant to the third of these topics, quantitative approaches. The reason for this is that much of the relevant literature on management theory and organization theory appears in Topic 1, Organizational Design, and that much of the relevant literature on accounting appears in Topic 5, Systems Acquisition Literature. In addition, the purpose of this section is to outline the analytical literature, which should be useful in constructing hypotheses and models for internal financial incentives.

The article below, by Jennergren, is a review of the literature in this area. The next four articles examine the usefulness of linear programming, non-linear programming, and game theory in structuring financial incentive systems that facilitate decentralization in economic organizations. The sixth article is a set of papers presented to the United Nations on government decentralization in a variety of countries, mostly socialist. The seventh and final article examines the allocation of projects and their associated funding by a central government agency to a set of subagencies.

"Decentralization in Organizations," by L. Peter Jennergren, International Institute of Management, Berlin, West Germany, March 1974. This is a working paper which will appear as a chapter in a forthcoming book, Handbook of Organizational Design, edited by William H. Starbuck. Its purpose is to survey the literature on decentralization of decision making (as opposed to the decentralization of facilities or logistics) in large multi-divisional organizations. Jennergren identifies four different clusters of articles which he labels management theory, organization theory, quantitative approaches, and accounting theory. The management literature describes and analyzes functional and divisional

decentralization in corporations, the organization theory literature explores relationships between decentralization and other organizational characteristics (e.g., the size of the organization), the quantitative literature uses operations research and management science techniques as models for decision making in the centralized organizations, and the accounting literature examines the construction of systems for performance evaluation of divisions of decentralized firms, including transfer pricing.

The usefulness of this article is similar to that of the UN document annotated below. That is, the most useful techniques are outlined in the analytical literature referred to above which spans the third and fourth topics specified by Jennergren. However, this article may suggest applications of some of the theories, especially in the organizational area, to the establishment and possible subsequent modification of design-to-cost goals. In this area, the author identifies four topics. The first is the measurement of the degree of centralization/decentralization in an organization, the second is the relationship between decentralization and other variables (such as specialization and standardization), the third is the relationship between decentralization and contextual variables (such as technology, size, and environment), and the fourth is the relationship between decentralization and performance variables (such as employee satisfaction, profitability, and production level). Since we will be concerned with the behavior of people confronted by a formal financial incentive system in a non-profit organization, these behavioral and organizational reactions may be of great interest.

"Efficient Distribution of Resources Through Three Levels of Government," by R. G. Cassidy, M. J. Kirby and W. M. Raike, in Management Science, Vol. 17, No. 8, April, 1971. This paper considers a decentralization scheme closely associated with internal financial incentives. The approach assumes that a number of government agencies are competing for resources which are dispersed by some Central Agency. Once funds have been dispersed to an agency the agency may invest them in any projects it wishes. The problem is to determine the "optimal" allocation

of resources to each agency under the assumption that the costs and benefits of all projects in each agency are known (i.e., reported completely) to the Central Agency. "Optimal" here is taken to mean minimizing relative regret among all agencies, where relative regret is defined as the percent of agency objectives attainable under the given allocation relative to what the agency could achieve if all its projects were funded. (The tendencies of agencies to generate additional projects, given this measurement of effectiveness, is ignored in the paper.) The Central Agency assumes when solving for optimal allocations that each reporting agency will report optimally whatever budget allocations are given, i.e., each agency is assumed to choose projects so as to maximize net benefits over all projects while satisfying its budget constraints. A computational algorithm is given for the Central Agency's problem.

The relevance of this article for the present research is that it highlights three important components in internal incentives design: 1.) informational requirements of the "Central Agency" in computing such incentives, 2.) the measure of effectiveness used, and 3.) the necessity for modeling sub-agency reactions to internal incentives. Unfortunately, this paper makes quite strong assumptions with respect to all of these matters. Moreover, few general insights are presented and main focus of the research is towards computational algorithms. The example in the paper is nonetheless interesting.

"Optimization, Decentralization, and Internal Pricing in Business Firms," by Kenneth Arrow, in Contributions to Scientific Research in Management, University of California, Los Angeles, 1959. In this article Arrow examines the ways in which a decentralized organization may implement a formal iterative scheme for preparing properly integrated divisional plans by means of a transfer pricing technique. The emphasis in this article is on the dynamics of the process by which the plan is prepared, and not on the equilibrium conditions for the existence of an optimal plan. Arrow develops a framework for preparing such plans based on a simple iterative algorithm for non-linear programming, in which the Lagrange multipliers or dual variables become the transfer prices. This is a

pioneering work in the area, and much has been done since then to extend Arrow's framework.

Arrow considers four types of planning processes and develops an analytical framework for each. In the first case there is perfect competition, and all goods are commodities. Arrow demonstrates that in this case divisional suboptimization leads to a global optimum. In the second case there is also perfect competition, but not all goods are commodities - that is, not all goods are traded on the market. In this case a nonlinear programming algorithm is used to provide a framework for the planning process, and the central agency integrating the divisional subplans does so by an iterative adjustment of transfer prices. Arrow also considers a simple extension of this second case, in which the only good not a commodity is capital available for internal investment, and the transfer price is the rate of return. In the third case there is imperfect competition - that is there is some substitutability between products, so that the revenue generated by the sale of any one product is a function of the amounts of the others sold. In this case the problem is more complex, and Arrow details the extensions and the framework needed to accommodate it. In the fourth case Arrow considers additional modifications needed to accommodate uncertainty in the technology of production and distribution. Finally, he considers two shortcomings of this approach. The first is that external relations to the divisions are difficult to incorporate into this framework, and it is necessary to develop more complex transfer pricing schemes. The second is the problem of increasing returns in revenues (or decreasing marginal costs) to scale, which violates the conditions of many nonlinear programming algorithms and, hence, negates the analytical framework that Arrow posits.

This work will be relevant to our project to the extent that weapons systems projects are interdependent and therefore may be coordinated by means of a transfer pricing strategy. In addition, a formal interactive scheme similar to Arrow's may be used to arrive at design-to-cost goals. This will require further investigation.

"Decomposition, Pricing for Decentralization, and External Economies", by William J. Baumol and Tibor Fabian, Management Science, Vol. II, No. 1, September 1964, pp. 1-32. This article is similar to Arrow's (above) in that it presents a transfer pricing mechanism for establishing a formal interactive scheme that integrates divisional subplans into a total plan that is both feasible and appropriate to the objectives of an organization. This article differs from Arrow's in that the framework is based on linear programming rather than nonlinear programming. The disadvantages of this approach is that the objective function and the constraints are linear; the advantage is that it makes possible a more complex set of interactions between divisions. Much of the paper is devoted to the development of a scheme by which a central agency may arrive at a set of interdivisional transfer prices based on the Danzig-Wolfe decomposition algorithm for linear programming. This technique is a centralized one in which the divisions submit at each iteration in the planning process a proposed decision vector, and the central agency iteratively prices out resources that affect more than one division in an attempt to elicit proposals which it can combine by a linear weighting technique to produce a set of decision vectors (one for each division) that optimizes the performance functions for the organization as a whole without violating any of the organizational constraints. (The divisional proposals are selected so as not to violate any of the divisional constraints.)

The potential applicability of this paper to our work is similar to that of Arrow's above. That is, the formal interactive transfer pricing scheme (based on dual variables) may be useful in pricing out interactions between weapon systems projects. In addition, design-to-cost goals may be established by a formal inovative scheme, and this approach may give insights as to how such a scheme might be developed.

"Short-Run Planning in a Decentralized Firm," by James T. Godfrey, The Accounting Review, Fall 1971, pp. 286-297. Like the Arrow and the Baumol and Fabian articles outlined above, Godfrey's paper presents a technique for decentralized planning. That is, he develops a formal structure for preparing a plan that meets the constraints within and between the separate

divisions of a large organization and that maximizes the performance function of the organization as a whole. This technique is based on linear programming, but it is less centralized than the Baumol and Fabian technique. The principal difference is that Godfrey places within each division not only the divisional constraints but an image of the interdivisional constraints, which is modified during each iteration. Thus, the divisions assume a greater burden in the planning process, and the analytical burden on the coordinating agency is reduced.

This article may have a few interesting implications for our study, because it provides an alternative to transfer pricing as a method for requiring separate divisions to recognize their impact, along with those of other divisions, on top level resources and constraints. On the other hand, if we do not probe in detail the interactions between separate weapons systems projects, this article may be of limited value.

"Two-Level Planning," by J. Kornai and T. H. Liptak, Econometrica, Vol. 33, No. 1, January 1965, pp. 141-169. This article is similar to the three listed above in that it attempts to formalize an iterative planning process in a decentralized organization by relying on an established operations research technique. In this case, the technique is the theory of zero-sum games, which is isomorphic to a linear programming formulation of the decentralization problem studied. This differs from the price-oriented decentralization systems, e.g., Baumol and Fabian, in that the central planning agency here allocates resources and receives marginal prices from the division which it then uses iteratively to reallocate resources. One of the interesting features of this article is that the authors are members of the Computing Center of the Hungarian Academy of Sciences, and they suggest that this procedure is being used as a guideline for national economic planning in Hungary. However, it is not clear to what extent these techniques are used as guidelines in the minds of the planners, and to what extent the guidelines determine or influence the planning procedures as seen by all of the participants.

The possible application of this article to our project lies not so much in what it says but in what it does not say. Specifically, it does not examine the use of side payments in establishing the financial goals of the separate divisions of a large organization, because these arise from non zero-sum games. Since the authors wish to present a technique that is isomorphic with linear programming (and only zero-sum games are isomorphic), they have not examined this rather interesting area. However, side payments may be very useful in establishing design-to-cost goals, and we may wish to consider this possibility.

"Multi-Level Planning and Decision Making," Papers Presented to the Sixth Meeting of Senior Economic Advisors to EEC Governments, United Nation, New York, 1970. This is a collection of seventeen papers on multi-level planning in different nations of the world. The first two papers provide an overview of this subject, and the remaining fifteen papers present examples from different nations. Two of the examples pertain to the United States, two to other Western nations, and the remainder to the socialist nations. The theme of the overview papers and of many of the individual national studies concerns the use of formal procedures, based on iterative optimization methods, in structuring an iterative planning system whose purpose is to integrate the subplans of the decentralized components of a government or of an economic system. However, none of the papers pays any significant attention to defense matters or to military weapons systems. This appears to be a useful guideline for interpreting some of the results of the Arrow and Baumol and Fabian papers, but I doubt that it presents anything of direct use to us in this project.

"A Generalized Goal Decomposition Model," by T. W. Ruefli, Management Science, Vol.17, No. 8, April, 1971, pp. 505-518. This paper is in the tradition of resource allocation in decentralized organizations. In this literature, two basic procedures had been previously proposed. The one, in

the Arrow and Baumol-Fabian tradition (see above), had a superordinate unit declare (transfer) prices for a common resource to subordinate units, which then responded with planned resource utilizations at those prices. This was continued until feasibility was attained. In the other, following Kornai-Liptak (see above), the subordinate units declared prices they would pay for additional units of resource and the superordinate unit responded with resource allocations. The present framework is different from both of these earlier approaches and attempts to allocate fixed resources among competing but otherwise separable management units so as to minimize total weighted deviations of management units' achievements from their goals. [A related paper by Ruefli in Management Science, June, 1971, treats the same problem but allows certain nonseparabilities among the management units' goals.]

This research is interesting in the present Project in specifying a class of hierarchical problems where targets (goals) are enforced on lower level decision units who must then trade off operating factors in attempting to meet these targets. Unfortunately only the general structure of the problem is given and no general qualitative results are presented to indicate the type of tradeoffs which one might expect under various conditions.

CONCLUSION

This literature is relevant to our project in that it examines the incentival and other issues relevant to decentralization within an economic organization. This project, on the other hand, is concerned with formal financial incentive systems in non-profit organizations. The principal difference is that a non-profit organization has objectives that are incommensurate, but not inconsistent, with sound economic performance. An example is the reliability of a weapons systems or the number of systems produced. Thus, the principal purpose of this project is to extend the literature described here and in Topic 4 below to organizations with both economic and non-economic objectives. The principal requirement here is for an analysis of the interactions between economic and non-economic objectives, and the literature described above does not examine this.

IV. INCENTIVES

The theory of incentives is concerned with problems of the following sort. One agent, let us call him the Central Planner, wishes to obtain the contributions of (say, privately owned factors of) a group of other agents, called for the moment contractors, towards accomplishing some desired end. The Central Planner is assumed to be able to choose and implement a reward scheme, dependent on contractors' factor contributions and addressed individually to each contractor. Thus, this incentive or reward scheme is the design variable used to induce contractors to contribute appropriate levels of their privately owned factors. The class of incentive systems allowed to the Central Planner is typically limited by fairness and "range-of-acceptance" considerations as well as by the available informational and administrative apparatus required to implement the incentive scheme in question.

A partial list of application areas for the theory of incentives includes wage and executive compensation schemes, regulation of public utilities, understanding and optimizing contractual arrangements between economic agents, designing management control systems for multi-divisional firms, sharecropping, public goods phenomena, and, of course, budgeting and other internal financial incentive mechanisms. Obviously we will have to be eclectic in this survey, and we have chosen to review literature principally from the following two areas: 1) the theory of contracts; and 2) incentives as instruments of organizational design. The first of these areas is concerned with the simplest form of the incentives problem, one involving only two people, sometimes called Principal and Agent. It is a useful starting point for posing the joint problems of monitoring, efficient risk-sharing and incentives. The papers by Ross and by Harris and Raviv are prime examples in this area.

The second area discussed is concerned with situations where a group of agents are involved in a jointly productive enterprise. Given some authority and information structure, one may then attempt to obtain desired output levels by manipulating the incentive structure. Examples of this are the work of Bonin on managerial decentralization and of Kleindorfer and Sertel on optimal enterprise design. A final area discussed is recent

research on contractual incentives in systems acquisition.

In the concluding remarks to this section we will review the relevance of research on incentives to our interest in internal financial incentives. For the papers reviewed below, we first deal with the theory of contracts and then proceed with increasingly complex organizational incentives problems.

"On the Economic Theory of Agency and the Principle of Similarity," by S. A. Ross, in M. Balch, D. McFadden, and S. Wu (eds.), Essays on Economics Behavior Under Uncertainty, North Holland, 1974. This paper and a companion piece by the author (in The American Economic Review, May, 1973) develop the theory of agency. Two economically motivated individuals are involved, the Principal and his Agent. The Agent selects an action x and an (uncertain) output $X(x,w)$ obtains, where w is a random variable, the "state of the world". The Principal is assumed to have a utility function $U[X(x,w)-f(X(x,w),w)]$, where $f(X,w)$ is the fee schedule, i.e., the amount of output X which is returned to the Agent in return for his services. The Agent is assumed to have a utility function $G(f(X(x,w),w)) = G(f)$ depending only on the fee schedule. The question of interest is what should the fee schedule f be. Several solutions are discussed: Pareto-Efficient (PE) solutions, Minimax solutions (S), and best linear fee schedules (L) where $f(X,w) = ax + b$ for suitable constants a, b . The reason that Minimax solutions are denoted by S is that the Principal's problem of finding any such solution (i.e., one minimizing the Principal's maximum opportunity cost) is solved by the so-called "Similarity Principle." This is achieved by solving for f such that, for some constants $a > 0, b$, $U[X-f(X,w)] = aG[f(X,w)]+b$. Intuitively, we choose the fee schedule so that the Principal and his Agent have equivalent utility assessments of wealth. Ross shows that any two of the solution concepts (PE, S and L) imply the third. He also investigates conditions on U and G under which (S) optimal fee schedules will be convex and concave.

The importance of this work for our Project is in providing a preliminary joint analysis of risk and incentives. This work has been considerably extended by Harris and Raviv [1976] (see below).

"Optimal Incentive Contracts with Imperfect Information," by Milton Harris and Artur Raviv, Working Paper No. 70-75-76, GSIA, Carnegie-Mellon University. This paper provides general results in the economic theory of agency (see also Ross [1974] reviewed above). There are two individuals involved, the principal and his agent. The agent is engaged in a productive act which has a monetary outcome valued at $X(x, w)$, where x is the agent's action and w is an exogenous random variable. The agent is assumed to have a utility function $u(S(z), x)$, where $S(z)$ is the agent's reward (paid by the principal) expressed as a function of an observable (by both principal and agent) random quantity z . The observation z is taken to be some function of x, w and $X(x, w)$. [Determining the effects of the form of $z(x, w, X)$ is one of the main problems addressed.] The principal is assumed to have a utility function $v(X(x, w) - S(z))$, i.e., depending only on the residual "profit" after paying the agent. The purpose of the paper is to consider the joint effects of monitoring and incentives: i.e., how to obtain an optimal monitoring system $z(x, w, X)$ and incentive payment function S . Such a pair $(S:z)$ is called a contract. Two cases are considered: 1.) the agent sees the realization of w before choosing x and 2.) he doesn't see w before choosing x . Key results obtained are structure theorems for optimal monitoring and characterizations of Pareto-optimal contracts under various assumptions on the utility functions involved. The paper is important for the present Project in structuring monitoring and incentive design problems in a unified framework, even though no explicit cost for monitoring itself is considered.

"On the Design of Managerial Incentive Structures in a Decentralized planning Environment," by John P. Bonin in American Economic Review, Vol. 66, No. 4, September, 1976, pp 682-687. This paper and the related work of Fan and other authors discussed in the paper is concerned with the joint problem of obtaining accurate target estimates (e.g., for cost or performance) from an economic agent who knows that his reward will be based on actual performance relative to the target estimates. Let X be a

variable of interest (e.g., cost of a project). Let Y be a target value for X which the project contractor reports to a central planner. X is assumed to be a random variable, whose distribution is known to the contractor but not to the central planner. Suppose that the contractor is paid according to the following rule when the true cost X of the project becomes known upon project completion.

$$\text{Reward} = A(X - B(X - Y)) \quad \text{if } X > Y,$$

and

$$\text{Reward} = A(X + C(X - Y)) \quad \text{if } X < Y.$$

In the above all the parameters, A, B, C , are assumed positive with B and C less than one. When $B = C$, the case treated by Fan in an earlier paper, a contractor who maximizes expected rewards can be shown to find it optimal to report the target value Y as being the median of his subjective probability distribution on X . When B and C are unequal, the contractor will raise (resp., lower) his reported target away from the median if $B > C$ (resp., $B < C$). Bonin also discusses how the control of B and C could be used to regulate the "tautness" of interrelated projects. Individuals with critical sub-projects would be given very high values of C relative to B so as to induce them to report cost estimates Y which would be conservative, thus allowing other aspects of the project to be planned on a safe-bet basis relative to interdependencies with critical sub-projects. This paper is highly relevant to the present Project in its joint treatment of incentives and monitoring problems.

"The Design of Mechanisms for Resource Allocation," by Leonid Hurwicz, in The American Economic Review, Vol. 63 (May 1973), 1-30. Hurwicz summarizes in this paper several strands of research relating to the efficient design of "resource allocation mechanisms (ram)". He discusses the important relationships between informational/computational requirements and planning and economic system design. He points out that feasibility considerations as well as efficiency and welfare comparisons of alternative ram's can only be done jointly over possible (informational/computational mechanisms, technologies, and preferences). A concrete way of specifying informational and computational requirements of a given enterprise design is on the basis of incentive schemes and the mechanisms which specify who sets such schemes and how they influence behavior (e.g.,

through effective utility maximization).

One of the most important incentive-related concepts discussed here is "incentives compatibility" of a given ram. This refers to whether participants will find it in their best interest to act according to their true preferences or whether "gaming" or opportunistic behavior may lead to increased felicity for at least some participants. As it turns out, very few ram's are incentives compatible in this sense.

This paper and the tradition it represents is central in the field of incentives. In structuring at a very general level the interrelations between incentives, technology, and information it provides the basic framework for most of the recent work in incentives.

"Incentives in Teams," by T. Groves, in Econometrica, Vol. 41 (1973), 701-710. The classical team theory approach assumes that members of an organization all share a common objective to which each member contributes through his actions. Given no conflict of interest, the classical team design problem is concerned with the design of appropriate informational mechanisms for coordinating decision-making, but no incentive problem is involved. Groves has extended this approach somewhat in the present paper to allow for conflict of interest among team members. Although Grove's results are interesting in setting the stage, they suffer from two major flaws from the point of view of modeling incentives in organizations. First, technological externalities (in production) between team members' behaviors are absent. Second, the distribution of incentives to organization members is assumed to cost nothing. With these two restrictions, however, Groves solves the combined communication and incentives problem through an incentive scheme which essentially causes everyone to share the same (overall organizational) objective. Several extensions of this paper are discussed below.

From the point of view of the present Project, this paper is important in being a forerunner for optimal internal organizational incentives.

"Information, Incentives, and the Internalization of Production Externalities," by Theodore Groves, in Theory and Measurement Of Economic Externalities, S. Lin (ed.), Academic Press, (1976). This paper considers a group of n economic agents whose activities are interdependent (e.g., one pollutes a stream which another agent, a brewer, makes use of in his production process), so that externalities exist. As a result, the agents may find it in their interest to "hire" a central agency (e.g., an industrial association) to coordinate their activities. The central question addressed is whether a decentralized coordination scheme exists which will jointly maximize the sum of "profits" resulting from the agents' collective activities. The type of coordination scheme envisaged is as follows. The agents send messages m (e.g., about their profit functions) to the central agency. The central agency then computes a joint strategy $z(m)$ which is, at the end of the coordination process, enforced. The major question addressed is the determination of incentives which will ensure truthful reporting (e.g., of profit functions), thus enabling the central agency to iteratively compute a group-optimal decision. The financial viability of the central agency is also discussed.

This paper is interesting in the incentives field for its explicit treatment of informational matters. However coordination and administrative costs are again ignored. Also, the assumption that all agents are satisfied to maximize the sum of profits presumes a lump sum transfer scheme ex-post. Another small problem with the paper from the point of view of internal financial incentives is that no allowance is made for the central agency to gather information on its own--it is totally dependent on the lower-level agents for its information.

"Incentives and Public Inputs," by T. Groves and M. Loeb, Journal of Public Inputs, Vol.4 (1975), 211-266. This paper is really just a special case of the Groves [1974] paper (see above) on internalizing externalities. In this case the externality is of the nature of a public good, with each of the n agents (or firms) having a net revenue function of the form $R_i(K, L_i)$ (before paying for K but after paying for L_i), K being a public good (entering each firm's revenue function at the same level) and L_i being a

local decision variable for firm i . From this point all else remains essentially as in the Groves article on externalities and the same reservations obtain. The authors do prove for a special case here, however, that the central agency can be made financially viable while still making the benefits of coordination strictly positive for each of the n agents (or firms) involved.

"The Simple Economics of Incentive Contracting: Note," by Michael E. Canes, in The American Economic Review, Vol.65 (June, 1975), 478-483. This is a comment on an earlier article by John McCall. Both papers address themselves to the subject of contractual incentives for government contracts. It is assumed that firms can invest their resources in either government work or in the "private sector". They are presumed to bid on government contracts setting their bid, (target cost of a project), so that their expected profits obtainable from the government contract, if awarded, will be precisely equal to those obtainable through private sector opportunities. Since these latter opportunities can be expected to be greater for efficient firms than for inefficient firms, it follows that efficient firms may be underbid by inefficient firms with consequent higher costs to the government. Canes shows that this phenomenon is ameliorated, but not eliminated, when a firm's bid is not just a target fee, but also involves setting the contractor government share ration for sharing cost overruns (or underruns). In all cases, however, the contractor is assumed to care only about profits (i.e., not about costs or sales) and to not be able to affect the expected cost outcome. A different set of assumptions is made in the Cummins paper reviewed immediately below.

"Incentive Contracting for National Defense: A Problem of Optimal Risk Sharing," by J. Michael Cummins, The Bell Journal of Economics, Vol. 8, No.1 (Spring, 1977), pp.168-185. The model studied begins by specifying the following profit function for a government contract awarded to a given contractor:

$$\text{Profit} = ay + x(y-B),$$

where "a" is the (assumed) fixed percentage of the negotiated cost estimate, "y", that determines the fee "ay". The parameter "x" is the contractor's share of any cost overrun or underrun, $0 \leq x \leq 1$; and "B" is the actual cost of the contract, so that $y-B$ represents the cost overrun. The contractor in contrast to the McCall-Canes model discussed above, is here assumed to have preferences represented by a utility function $U(\text{profit}, B)$, i.e., the contractor cares not only about profits, but also about realized costs. Cummins assumes, in fact, that the contractor prefers higher costs to lower, as long as profit remains unchanged, which is not unreasonable if we think of costs as sales. He then determines the Pareto set (the undominated (x, y) pairs resulting from contract negotiations) for the contractor and a government agent whose preferences are assumed to be only in terms of expected total cost to the government = profit + B. This is done under the assumption that the government agent and the contractor know one another's preferences and share a common understanding of any (e.g., technological or economic) uncertainties relevant to the contract. The interesting result of all this is that the Pareto set is characterized in part by the changes in final expected costs B which the contractor will "cause" as a function of changes in the share rate (x) and the target fee (y). Little is said about the impact of financial structure or contractor efficiency in relation to these change factors, and this would be a fascinating empirical follow-up to the interesting characterization of equilibrium contracts provided here. Of further interest in our own Project would be the coupling of this sort of external model to a multi-level model of the internal structure of the government agency in question.

CONCLUSIONS

The literature on incentives provides insights into optimal incentives design and related informational issues. To date, however, the results reported on incentives must be viewed as very preliminary since there is practically no empirical research to corroborate the credibility of either their assumptions or their conclusions.

The most important results in this literature related to internal incentives are the work of Hurwicz on incentives compatibility, Groves' result on optimal incentives structures, and the work of Ross (see also Harris and Raviv) on jointly optimal incentives and information systems. All of these results are purely theoretical but are suggestive of a structure for empirically understanding incentives. What they suggest is that differences in preferences (including risk preferences) or asymmetry in access to information or other privileged endowments induce an incentives problem. Furthermore, the design and implementation of optimal incentives requires a joint concern with monitoring and communication systems.

The major lacunae in the literature are in two areas: first, in empirical corroboration of any of the several incentives design problems posed; and, second, in extending the theory of incentives to deal with multi-level organizations as well as with the time dimension. The first needs no explanation and is, in fact, a major focus of the current Project. As to the second, the point here is that most of the theory to date has been static. In particular, questions of unfolding information over time have been largely neglected. As an example, it is clear in systems acquisition that final cost and profit uncertainty change radically over time (thus impacting directly on risk and informational aspects of the incentives problem). The coordination of such time-dependent risk and monitoring problems in systems acquisition with organizational aspects of (intragovernmental) planning and control of implementation is a key goal of our research, but is only barely touched upon by the incentives literature to date. Finally, many of the interesting problems in incentives are associated with monitoring, so one hopes that an empirical understanding of the costs and benefits of monitoring begins to emerge.

V. SYSTEMS ACQUISITION LITERATURE

Until the mid 1960's the Defense Department and the defense industry were virtually autonomous. They seldom had difficulty in winning Congressional and administrative support for any of the programs they wished to initiate. During the decade of the 50's, defense business was characterized by advanced technology, concurrency and cost-plus-fixed-fee contracting. Because both development and production were carried out under cost reimbursement contracts, production cost was not a major constraint on engineering design. In fact, manufacturing personnel were often not even required to advise engineers of the cost implications of various design alternatives. Money was made available for production of advanced technology designs which promised a performance advantage over the "enemies" counterpart. As the newly trained innovative engineers came into dominance, the old cost-conscious, applied science practitioners decreased in number and influence in the defense community.

The National Security Industrial Association in their 1970 Defense Acquisition Study claims that it was the evolution of the non-cost-conscious manager which has contributed to bringing about the "promulgation of a vast array of government imposed management systems, controls and reports, in an effort to force improved management discipline in technical, cost and schedule performance.*

In fact, these attempts are a symptom of the growing cost consciousness on the part of Congress and the public, who have been questioning the continuing need for spiraling defense appropriations. Present trends suggest that even when holding all other factors constant, the cost issue will get worse since: (1) there has been a trend towards a decrease in the proportion of the Federal Budget allocated to defense, (2) real dollar value has declined, (3) factor costs of labor and fabrication have increased.

* National Security Industrial Association, Defense Acquisition Study: Washington, D.C., July 1, 1970.

GAO has suggested in their 1973 study** on cost growth in Major Weapons Systems that the formidable cost growths are caused by three factors: (1) increases resulting from the greater capability demanded of new systems which in turn require greater complexity. (2) inflation, (3) increases resulting from management processes during development design and production.

Whatever the reason for cost growth, it is clear that increased pressure to control such growth will continue to plague major systems acquisitions. The primary battleground for resolving the resulting conflicts will be the Federal budgeting process.

The annual defense budget that is presented before Congress takes place 12-18 months prior to the Congressional committee hearings on defense appropriations. Defense Department officials determine defense needs in part on the basis of requests from field units. Since several years elapse before military field units actually acquire the weapons requested, these units must attempt to predict their needs several years in advance.

As program and funding requests move up from the field to military headquarters, the individual cost estimates are often greatly reduced so as to secure authorization from Congress for as many programs as possible. Fox [1973] refers to this as the "foot in the door technique" since once any program is funded, Congress can usually be prevailed upon to keep it going, regardless, Fox claims, of cost, schedule, or performance irregularities.

Planning and defending the defense budget has to occur so far in advance that when time comes to spend the money, the services do so whether they need the product or not. Particularly since reprogramming is difficult to accomplish and frowned on by Congress, the tendency is to fund what was originally requested. Put another way, there are few positive incentives in the Congressional appropriations arena for any organization to not fully dispose of its total annual appropriation. In fact, if appropriated money is not spent, the organization will most certainly invite closer scrutiny with subsequent funding requests viewed with suspicion or reduced. Another critical aspect of the appropriations

** Cost Growth for Major Weapon Systems, Report to the Committee on Armed Services, House of Representatives by the Comptroller General of the United States, March 26, 1973 (reviewed below).

process is that Congress itself does not have adequate staff nor resources to fully comprehend and arrive at reasonable evaluations of weapons acquisitions requests. As a result, the present DOD-Congress relationship appears to be counterproductive in terms of providing efficiency incentives.

The policy shift in the 1960's to fewer, but more highly sophisticated, multipurpose weapons had a number of collateral and serious side effects. With fewer weapons going into development, production capacity became excess, particularly in the aerospace and shipbuilding industries. In those industries, whether or not a contractor obtains one of the scarce development contracts can mean the difference between its staying in the business or being forced out. This in turn pressures competing contractors to submit optimistically low bids.

The competitive urge, both among the contractors to obtain a contract and among the services to produce and field highly advanced weapons, encourages excessive optimism as to the technical unknowns to be resolved and the most likely total cost. Although DOD policy contemplates an orderly evolution of technology from research through the various phases to development and production, in practice this unwarranted optimism often induces only partial completion of early development in order to hasten and insure full program authorization. This in turn can lead to the all too familiar pattern of production and operational difficulties, delays, changes and significant cost overruns. The cycle is further perpetuated by the "foot in the door" mentality encouraged by the existing Congressional appropriation pattern.

As will be seen in the literature reviewed below, the weapons acquisition process is controlled through a hierarchy which contains two types of bureaucracy: an internal bureaucracy consisting of the Department of Defense and related internal agencies; and an external bureaucracy, consisting of the agencies concerned with regulating between the Defense Department and Congress, and between the Defense Services and their contractors. This environment gives rise to a unique incentives system. To mention just a few problems relating to external relations, we note that the Congressional appropriations mechanisms encourage full usage of all monies allocated and discourage transfer of funds from one program to another. Because of the very long turn around time between initial request

and final delivery of a weapon system, funding requirements must be anticipated several years in advance. The Defense Department relations with its contractors are also complicated. Part of the problem derives from the high technology nature of the weapons acquisition field. Not only are there very high entry barriers for new firms wishing to provide services to the Defense Department, there is also a first mover advantage for the firm that receives an initial development contract, to proceed with all phases of the system.*

The complexities hinted at above on the external side are reflected and reinforced by further internal management problems within the several agencies involved with systems acquisition. A very critical problem that pervades the field is that of cost, time and performance estimation. There are two sets of problems in this area. First, of all it is difficult to anticipate the time and cost associated with a given technological breakthrough. Thus, it is difficult to weigh and accurately compare different systems which potentially address the same strategic mission. A secondary effect of this unknown is that these "R and D frontier costs" are difficult to isolate because of the lack of uniform usage of cost allocation formulas.

The added dimensions of real dollar decline, increase in factor costs, and the decreasing proportion of Federal monies allocated to Defense, have served as an impetus to define more stringent cost control methods. Total Package Procurement, Incentive Contracting, and design-to-cost have been methods introduced in an attempt to deal with these cost control issues as well as with associated budgetary and interagency coordination problems. In this part of the bibliography, we examine some of the literature which analyzes the effects and limitations of these techniques.

* Although in theory, competition on bids is encouraged, in practice, according to Admiral Hyman Rickover, "Only about 11% of the Defense procurement budget is awarded under truly competitive conditions, and 57% of the defense procurement budget is spent on sole source contracts." (See Statement before the Senate Armed Services Committee, April 28, 1977).

Defense Management Journal "Design-to-Cost" special issue, September 1974. This special issue of Defense Management Journal was prepared by the staff of the Office of the Secretary of Defense.

Design-to-cost is defined by Jacques Gansler, OASD and George Sutherland, ODDRE, as the management and control of future acquisition, operating, and support costs during the design and development process under established and approved cost objectives. A design-to-cost goal is defined as a specific cost number (in constant dollars for a specified number of systems at a defined production rate, established as early as possible in the acquisition process.

Initial design-to-cost efforts were largely production cost oriented. The first article suggests there is now widespread recognition that design-to-cost must "think" life-cycle cost. The intent of DOD 5000.1 is to emphasize the need to balance, through an iterative design process, performance, cost and schedule with quantities needed to achieve the most effective military capability from available DOD resources, and that total force effectiveness, rather than an individual weapon's effectiveness should be considered. A number of reasons can make the life/cycle cost approach difficult to implement. For example, better DOD cost accounting methods are needed to associate major costs of operations and support with specific systems.

The article by Brigadier General M. J. Tashjian, then the Director of Procurement Policy, OASD (I&L), on "Implementation of The Design-to-Cost Concept from the Contractual Point of View", highlights what has been learned about the implementation of design-to-cost in four principle areas: advanced procurement planning, preparation of the request for proposal, (RFP), contractual coverage, and post award administration of the contract. The primary reasons why the relationship between production, operating, and support costs is so difficult to handle are centered in the lack of uniform definitions and cost accumulation systems which can effectively estimate future operating and support costs. The currently suggested ways to handle this problem appear to be the use of performance parameters such as meantime between failures, meantime to repair, maintenance manhours per operating hour or maintenance turnaround time per mission.

Based upon observations, Tashjian claims that continuing competition as long as possible during the acquisition cycle is the best way to get a system which performs the mission within the design-to-cost goal. Many of the best chances, to make performance trade-offs within the design-to-cost goal occur early in the design phase. However in over 40% of the contracts reviewed the design-to-cost requirement had been added after the basic contract was executed.

Tashjian states that the RFP should clearly state the relative importance of the performance requirements by either rank ordering performance requirements into mandatory significant and desired categories or else arraying the performance parameter with attached upper and lower boundaries of acceptability. Another feature which he thinks should be covered in the RFP is the manner in which the government requires the contractor to implement the design-to-cost requirement.

Four contractual techniques have been used to motivate contractors to meet both the performance and design-to-cost goals : 1) stating in a schedule clause of the development contract the intention to cancel the program if the design-to-cost goal was breached, 2) relating profit on the production contract to the contractor's success in reaching the design-to-cost goal set during the development contract; 3) requiring the contractor to complete one milestone before going on to the next one with the threat of termination of the program if the contractor is unable meet the cost goals for any particular milestone; 4) using an incentive award structured to provide substantial dollars tied to the governments' evaluation of the contractor's success in applying design-to-cost. Subcontracts should provide for the flow down of the pertinent design to cost provisions in the prime contracts.

An important consideration in establishing design-to-cost goals is the tradeoff between acquiring a large number of systems with moderate performance capabilities vs. a lesser number of systems with greater performance capabilities. Design-to-cost requires restraint on the part of the Government in specifying minimum performance goals. Tashjian suggests that the specification of performance goals should be limited to that level below which the system would be of unacceptable operational value to DOD, since it is anticipated that industry will be driven by competitive pressures and incentives to surpass these minima.

Tashjian also claims that fundamental to the success of design-to-cost is early and continuing feedback between the design and production engineering groups. Production cost goals from a contractual viewpoint should have reasonable flexibility in early phases because of the application of new technology often involving considerable risk. However, firm unit price options for limited production quantities are desirable if, feasible in the full scale development phase.

"Application of Design-to-Cost Concept to Major Weapon Systems Acquisitions," Report to Congress by the Comptroller General of the United States, U.S. General Accounting Office, Washington, D.C., June 23, 1975. This report examines the design-to-cost concept for military weapon systems, describes the status of implementation of design-to-cost in DOD, examines some of the problems of implementing design-to-cost, and examines some of the effects of design-to-cost. GAO defines design-to-cost as a system for establishing unit cost goals for the production of a large number of weapon systems. The system is viewed primarily as a cost control device, and not as a financial incentive system. Furthermore, performance is considered a constraint, not a parameter to be traded off with system cost.

With regard to the status of design-to-cost, the report states that, "As of December, 1974, there were 54 major weapon systems in the acquisition cycle that had not reached the production phase. Of these, design-to-cost goals were established for 26, and will be established for 23 others, before they reach full scale development phase." The report also states that design-to-cost goals were established at different points in the acquisition process for these different projects. Some were established early in concept formulation while others were established later during the development phase. The report states that this was because the projects were in different stages when the decision to implement design-to-cost was made. It does not suggest that design-to-cost might be appropriate at different stages of the development cycle for different types of projects.

With regard to the implementation of design-to-cost, the report outlines three problems. The first is in establishing a reasonable cost target. For most weapon systems, only a limited amount of relevant historical data is available, and this greatly aggravates the cost estimation process. The second problem is confirming that the system will meet the design-to-cost goal (defined as a unit cost of production) after the development process but before production. The third problem is changes in the mission of the system which result in design changes that affect the cost target. The report states that a certain amount of flexibility in design-to-cost goals is necessary because of design changes, but that a substantial change in the goals should result in a re-evaluation of the project. Finally, the report describes a "changing approach to designing weapons," which consists of an explicit recognition of the alternative design strategies and trade-offs between cost and performance. This may assist in setting a reasonable cost goal.

With regard to the impact of design-to-cost on acquisition practices, the report mentions four topics. The first is the effect on life cycle costs. The report suggests that design-to-cost may be extended to include life cycle costs, but there are problems in cost prediction that make this difficult. The second topic is system versatility. The additional controls required by design-to-cost "may limit opportunities to design weapons with built-in growth potential." In addition, they may not be applicable to weapon systems with multiple missions or systems that are intended to satisfy multi-service needs. The third topic is technological advances. The report suggests that "with this commitment to designing affordable systems, engineering innovativeness could be inhibited, slowing the pace of major technological breakthroughs." The fourth topic is product improvement programs. The report suggests that some services may "enlist sufficient support for reinstating, through subsequent product improvement programs, system features discarded earlier because of high cost." Thus, attempts may be made to circumvent the design-to-cost system by instituting design changes that increase the design-to-cost goals.

The conclusion of the report outlines one of the difficulties of measuring the benefits of design-to-cost. Since design-to-cost was implemented during a period of high inflation, it is difficult to determine its effects on cost control. In other words, "it is unfortunate that

design-to-cost came into existence at a time when inflation's effect on weapon system costs has become so devastating that a comparison of current cost estimates with the design-to-cost goals could easily obscure the efforts made to hold down cost."

"Design-to-Cost -- Problem Definition, Survey of Potential Actions and Observations on Limitations," by James D. McCullough, Paper P-928, Institute of Defense Analyses, January, 1973. After discussing the increasing public concern with the DOD budget and associated problems, the author turns his attention to design-to-cost as one of the suggested tools for dealing with cost growth in major weapons systems. He first notes that there are several competing notions of what design-to-cost is. Most of the literature suggests that it applies to a total weapon system. However, he notes, in practice it appears to be primarily used during the production phase of the life cycle. This may be because of poor data collection systems for operating costs. It may also be a simple reflection of the fact that there are no contractual mechanisms for enforcing operating cost specifications.

A second area addressed is what potential actions might be taken to achieve design-to-cost goals. The author suggests that these might include limiting the introduction of new technology (since most of the cost growth has been in high risk technology systems), tightly managing new technology and tailoring contracts to the degree of risk inherent in technology. Finally, government and contractor interactions should be better coordinated relative to design specifications and cost goals.

The paper concludes with some observations on probable areas in design-to-cost. These include, foremost, the inappropriate use of design-to-cost in systems requiring new technology where high risks are involved. The author believes that design-to-cost was really meant to be applied only after most of the risks have been eliminated (e.g., through building prototypes). The author also notes behavioral problems of getting contractors and DOD to estimate costs properly if an absolute design-to-cost goal is imposed. Finally, the author notes that the continued concentration of DOD and the defense industry on performance

rather than on quality (e.g., reliability) and cost must be changed if design-to-cost is to achieve its purpose.

As a final note on this paper and its relevance to the project, McCullough does not discuss the internal incentives effects of design-to-cost, but appears to consider design-to-cost mostly in relation to Contractual relations with Defense Contractors.

"Design-to-Cost of Naval Ships", by R. Leopold, O. P. Jons, and J. T. Drewry, in Proceedings of the Society of Naval Architects and Marine Engineers, Vol. 9, No. 5, 1974, pp. 1-27. The paper begins by reviewing the history and present (1974) status of design-to-cost. The authors point out that the main focus of design-to-cost is in unit production cost targets, though there is still some ambiguity about this (see, e.g., the 1975 GAO Report to the Congress). An interesting point made by the authors is that design-to-cost is not the same as "Total Package Procurement", inasmuch as design-to-cost is interpreted to be only one part of a flexible set of policies (including parallel development, incentives contracting etc.) intended to be closely coordinated with the characteristics of the system in question, whereas Total Package Procurement required early and complete commitment to all aspects of the system (cost, performance and time limits). The following problems and issues are delineated in assessing design-to-cost:

1. What should the Cost constraint be and how should it be established in design-to-cost?
2. At what point in the system life-cycle should the cost constraint be established?
3. How should cost be controlled to stay within the established cost constraint? In particular, at what point of cost growth or performance and number of copies degradation should a system be scrapped or revalidated?

The paper points out that the naval ship is a special type of weapon system and therefore requires specialized procedures in applying design-to-cost. The particularities of naval ships are: bigness and complexity; disparities between the lifespan of the ship as a weapon platform and the lifespans of the weapons payload it carries; long development period (10 to 20 years); small numbers and high unit cost per copy. These considerations lead the authors to suggest several detailed recommendations for the application of the design-to-cost concept to naval ships. Foremost among these recommendations is that detailed design definition be completed before cost constraints are specified.

This paper is also relevant to the Project in its discussion of the process oriented issues associated with the implementation of design-to-cost. In particular, the paper suggests that strong information and organizational links be set up between users and designers of systems and that strong centralized project management and design organization be established in order to achieve necessary compromises through intensive cost--performance tradeoffs. The issue of design-to-cost as an internal financial incentive within DOD is only marginally addressed in the paper.

"Major System Acquisitions: A Discussion of the Application of OMB Circular No. A-109," Executive Office of the President, Office of Management and Budget, Office of Federal Procurement Policy, August, 1976. OMB Circular No. A-109 is a statement of a new policy for the acquisition of major systems by all executive branch agencies, and was arrived at by the Director of OMB and the Administrator of OFPP. Its purpose is to effect reforms that will reduce cost overruns in such areas as federal office buildings, hospitals, energy demonstration programs, transportation systems, and defense and space systems. For the most part, Circular A-109 does not apply to social programs. The document states that the policies articulated in Circular A-109 and summarized here are consistent with the recommendations of the Commission on Government Procurement.

The two major topics covered in this document are applications of the provisions of Circular A-109 (1) at five different stages of the system acquisition cycle, and (2) to three different types of systems and

projects: ADP systems, construction projects, and demonstration projects. The five stages of the acquisition cycle are described as (1) mission analysis, (2) exploration of alternative systems, (3) competitive demonstrations, (4) full-scale development and initial production, and (5) production. In addition to the two major topics, the document also briefly examines the technology base for major systems, the relationship between the system its subsystems, and the need for proper budgetary planning and control.

With regard to the acquisition cycle, Circular A-109 has implications for each of the phases of the acquisition cycle. The first is mission analysis. A-109 requires a mission need statement which includes the mission purpose, capability, agency components involved, time constraints, value or worth of meeting the need, relative priority, and operating constraints. The mission need statement is submitted to the appropriate agency head for approval.

The second phase is exploration of alternative systems. This part of the report presents a number of general guidelines for this stage of the acquisition process (e.g., "The program manager ideally should be a multi-discipline, experienced manager with sufficient tenure and interest in the program to provide continuity and to approve personal accountability for his actions."), but it says little about the applicability of Circular A-109 to this process. The principal statements are a reaffirmation of the government commitment to rely on the private sector for systems acquisition to the maximum extent possible. The report also states the advisability of making maximum use of parallel development for major projects in order to reduce the delays inherent in large sequential projects.

The third stage is competitive demonstrations. Again, the report offers general guidelines (e.g., "Competitive demonstrations are intended to verify that the chosen concepts are sound, perform in an operational environment, and provide a basis for selection of the system design concept(s) to be continued in the full scale development.") However, it says little about the application of Circular A-109 to this stage process.

The fourth stage is full-scale development and initiation process. The decision to proceed with full-scale development should be made on the basis of (1) system concept performance, (2) an analysis of remaining

risks, (3) an evaluation of estimated acquisition and ownership costs (full life-cycle costs, including cost of operation and maintenance, are not mentioned here), (4) capabilities of the contractor. Any special provisions of Circular A-109 are not mentioned here.

The fifth and final stage is production. Nothing of significance is said here, except that the acquisition process should be considered a full cycle in which the other stages are repeated as necessary.

The second major part of the report is applications of the provisions of Circular A-109 to ADP systems, construction projects, and demonstration projects. The description of the applications is straightforward. The remainder of the report is a brief examination of three topics: technology base, subsystem development, and budgeting. The material on technology base reaffirms the government's position making effective use of the private sector in research, design and development, and test, evaluation, and demonstration of new systems. With regard to subsystem development, the report states that, "Subsystems that may be candidates for inclusion in a major system acquisition program are not to be fully developed until the subsystem has identified the part of the system proposed for full scale development (i.e., at the end of demonstration and evaluation)." With regard to budgeting, the document states that Circular A-109 highlights the requirement of the Budgeting and Accounting Act of 1921 and the Congressional Budget Act of 1974 that the budget must contain a presentation of agency missions (1) the general technology base that supports the agency's overall missions, (2) specific development efforts that support alternative system design concepts, and (3) full-scale development of systems related to mission needs. This will begin with the budget prepared for FY 1979.

"System Acquisition Strategies". RAND R-733-PR/ARPA Robert Perry, Giles K. Smith, Alvin J. Harman, and Susan Henrichsen. This report is a review and summary of some of the research and findings of the RAND system acquisition study presented to DDR&E in 1969 and 1970, and a statement of some policy implications. This analysis of 36 major DOD weapon acquisition systems, together with observations of European aircraft development

practices and non-standard American programs, identified some major causes of high system cost. Basically, "High system cost and cost growth appear to arise primarily from efforts to subdue difficult technology on highly compressed schedules and an apparent willingness to pay whatever is required to insure satisfaction of original or even expanded system performance goals."

The RAND report proposes two major changes: an incremental strategy involving a sequence of decision points; and considerable austerity in the early phase of development.

RAND studies conducted in 1971 (Klein, Glennan, and Shubert)* suggest that the time required for the development of a system by incremental processes is not greater than the time required for the development of a similar process by "concurrent" processes, thus refuting the assertion that development and production must overlap to hasten the delivery of an operationally ready system.

The austere initial development strategy suggests that resources be sharply constrained during the "performance demonstration" phase. Two classes of benefit accrue from this strategy: direction and goals of small austere programs can be changed quickly; and initial austerity makes possible the funding of multiple competitive sources during the early development phases.

Furthermore, there are significant cost advantages in delaying work not relevant to the phase of development in progress. For example, spare parts, consumption rates and maintenance requirements can be calculated far more accurately once test articles are in hand.

"Incentive Contracting Guide," October 1969, Department of Defense and National Aeronautics and Space Administration. This guide discusses the pros and cons of each of the four methods of making equitable adjustments

* The Role of Prototypes in Development, RAND, 1971
RM-3467-1-PR

to incentive contracts which are: Individual Element Adjusted Method - i.e., determining the effect of the change on each element such as target cost, target profit and ceiling price; The Constant Dollar Method where the same dollar adjustment is applied to target, maximum and minimum fee or profit and ceiling price; The Constant Percentage Method - where the percentage of maximum and minimum fee or the percentage of ceiling price over target cost is held constant; and The Severable Change Method - where the change is isolated from the incentive provisions. In effect a separate agreement is reached as to the change portion.

The Severable Change Method is most recommended where the uncertainties introduced by the change would substantially alter the original contract cost/performance ratio.

Fisher, Irving N. A Reappraisal of Incentive Contracting Experience RM-5700-PR, June 1968. This study deals with the effectiveness of incentive contracts as a means of controlling defense procurement costs. The purpose of incentive contracts is to encourage contractors to achieve cost underruns by increasing the total profit as actual costs are reduced below a predetermined cost target.

Fisher presents empirical evidence that suggests that incentive contracts have not accomplished their intended goals of increased efficiency and lower procurement costs. He suggests that a less obvious way for a contractor to achieve the desired cost-underrun effect is to initially obtain a target cost which exceeds the expected actual cost, which results in larger underruns and increased profits that are unrelated to any real cost savings.

This situation can exist since most weapon system production and support contracts are presently negotiated without price competition. Furthermore, because it is common practice to award production and other follow-on contracts for weapon systems to the original development contractor, effective price rivalry can exist only at the first stage of a weapon system acquisition program, the development stage.

Fisher concludes by pointing out that the most significant improvements in incentive contracting techniques will not be realized through more elaborate pricing arrangements or incentive structures, but rather through improved methods for obtaining target costs, targets that more closely reflect the contractor's anticipated costs.

Fisher briefly mentions alternative strategies for increased competition proposed in recent years from total package procurement to a strategy of complete separation. However in situations where price rivalry cannot be effectively used, DOD must increasingly rely on its own cost estimating techniques. Some procurement officials Fisher claims now appear to believe that cost estimating techniques can be so refined as to become an effective substitute for price competition in establishing realistic target costs.

The basic problem with cost-estimating techniques now in use is the fact that they are historically based: if the costs for previous weapon system procurements were not obtained competitively, the resulting estimates cannot be regarded as being comparable to competitively determined costs. The majority of the weapon systems contracts in DOD's data bank were not awarded competitively; even if they had been, the resulting cost estimates utilize data from a number of contracts with different contractors. Since some contractors are more efficient than others the estimated cost is in reality an average cost.

Fisher also suggests that better project definition prior to negotiating the incentive structure (particularly in cases where great technical uncertainty is involved) could contribute much toward improving the effectiveness of these contracts.

National Security Industrial Association Defense Acquisition Study,
Washington, D.C., July 1, 1970.*

* The National Security Industrial Association is a non-profit, non-political association of over 300 American industrial and research organizations representing all segments of the Defense Industry. It sees its function is to promote and provide for effective communications between industry and the government in matters relating to National Security.

This study deals with the full range of the defense acquisition process, examining major problems and making recommendations for improvements. The report is based on the premise that the U. S. weapons requirements can be best filled through the operation of the profit motivated free enterprise system.

The NSIA report suggests that part of the problem with DOD policy is that it contemplates an orderly evolution of technology through production and that this unwarranted optimism (regarding technical unknowns and most likely total cost) often induces only partial completion of early development in order to hasten and insure full program authorization.

Both the competition among the military services for available budget dollars and the competition among industry to bid low to obtain contracts, increases the prevalent over optimism which works against realistic technical assessment and planning based on realistic cost and schedule estimates.

The government has two alternative action plans (or some combination) of either undertaking itself the detailed weapon system planning and management or contracting out. In either case the quality of the program product depends heavily on the management effectiveness of the government program offices.

To a degree not experienced in the typical commercial marketplace, the demand for defense products and services is susceptible to abnormal fluctuations, such as sudden changes in the nature of the international situation, the nature of the enemy threat, or a change of administration can result in unpredictable program cancellations, contract termination or contract stretch-out. An economic theory governing defense acquisition should include these risk and uncertainty factors. The fluctuating levels of employment and transient work force experienced by many defense contractors have made creation and maintenance of a smoothly functioning team very difficult.

NSIA sees the biggest handicap to a smooth functioning system as the implementation issue, i.e. the mismatch between policies and practices.

"The Impact of Required Contractual Clauses on Systems Acquisition Policies: The Case of Value Engineering". by Geneese G. Baumbusch, prepared for the United States Air Force, Project Rand, R-1722-PR, September, 1975. This report is a study of "value engineering" regulations which is one aspect of procurement regulations that was intended to encourage defense contractors to cut costs. This paper analyzes the effectiveness of value engineering within a design-to-cost framework. The report stresses that certain attitudes and approaches have been at least partly responsible for the frustration of contractual Value Engineering goals and that there is a need to reconsider current approaches to risk assumption, contractor cost and contractor profit.

The report suggests that contractor cost control should be encouraged by the "increased use of fixed price contracting for discrete phases of development and production, along with more competition". The report claims that this system would benefit the contractor in the form of reduced necessity for government controls and interference and is expected to do more to encourage cost control than sole source cost plus contracting. The problem with cost plus contracting lies in the fact that a contractor's efforts to control costs can result in adverse impacts on his organization and may actually net him a lower profit potential on successive contracts.

The report suggests that the claimed savings attributed to Value Engineering clauses have not been particularly large, and that in fact "if all the real costs of trying to use a complex, unwieldy contractual device to achieve this laudable goal could be adequately measured, the savings would be even less significant".

The final recommendation of the the report is to shift emphasis to a "cost oriented" concern rather than a "profit oriented" concern. In that line, it is recommended that "good contractor performance (which of course includes cost performance) deserves a substantial profit". Contracting devices that allow the contractor to keep what he does not spend are recommended.

In sum, this analysis of Value Engineering clauses suggests that without more fundamental change, these clauses are unlikely to work much more effectively in design-to-cost contracting than in the past. However the potential exists for Value Engineering to become an automatic part of

design-to-cost if the more fundamental changes occur.

CONCLUSION

This brief survey of the literature points to the vastly differing opinions on both what the problems are in weapons acquisitions and the relative merits of various solution strategies. In particular, the differing interpretations of the purpose and function of design-to-cost suggests that in its present form, design-to-cost will not have a uniform impact. Design-to-cost is viewed primarily as a cost control device, and not as an internal or external financial incentive system. Performance is treated as a constraint, rather than as a parameter to be traded off with system cost. The biggest issue which design-to-cost does not satisfactorily address is the cost estimation problem.

CONCLUSION

The principal conclusions that we have drawn from the examination of the literature outlined above is that there are substantial gaps with regard to the establishment of internal financial incentive systems in non-profit organizations. These gaps may be grouped into three major categories: (1) resource allocation, (2) incentives, and (3) organizational design and behavior. The gaps are both theoretical and empirical. That is, there is a need both for a fuller understanding of the differences between profit and non-profit organizations with regard to internal financial incentives, and there is a need for empirical research in this area as well. During the remainder of this project we will attempt both to extend the theoretical literature in order to generate hypothesis and to obtain data in order to test these hypotheses. Although we cannot at present state these hypotheses in detail, they will all concern the relationships between financial and non-financial performance measures in non-profit organizations and the extent to which formal financial incentive systems influence non-financial behavior.

It was mentioned above that there are three major gaps in the literature. The first is in the area of resource allocation. The principal issue here is the relationship between budgetary systems used to allocate financial resources and financial incentive systems. In some instances - for example, responsibility center management in a private corporation - the resource allocation system is a subsystem of the financial incentive system, and budgets are prepared in response to formal financial incentives. However, in the government the process seems to be reversed - that is, major budgetary decisions are made at the OMB and DOD levels, and the design-to-cost system that gives rise to financial incentives operates at and below the USN level.

There are three principal questions with regards to resource allocation. The first concerns planning. The question is: how do long range plans prepared or reviewed as part of the budget process affect the design-to-cost goals that establish financial incentives within USN? The second issue concerns control. The question here is: how does the budgetary control system established and maintained by OMB, DOD, and USN effect any possible modification of design-to-cost goals for projects

already undertaken? The third question concerns the iterative and hierarchical nature of the budget and acquisition process. The question is: to what extent are formal iterative planning and control processes used to interface resource allocation and incentives systems across several hierarchical levels?

The second major gap in literature concerns incentives. The three principal types of literature in this area concern (1) the types of monitoring systems appropriate to R&D projects to exploit the reduction of uncertainty which takes place as the project progresses, (2) a theory of agencies that determines the type of fee schedule established by a principal or government agency dealing with an agent (or contractor, where the fee schedule affects both the objectives of the principal and actions of the agents, and (3) the ways in which principal/agent interactions occur among the different levels of a multi-level hierarchical organization.

We intend to investigate two principal issues in this area. The first concerns the coordination of risk, incentives, and monitoring in life cycle problems. This requires that we (1) extend the theories outlined above to include non-financial variables, and (2) examine the interactions between budget constraints and financial objectives. The second issue is the extension of the first issue to multi-level hierarchical organizations.

The third category of gaps in literature is organizational design and behavior. This literature suggests there are three organizational responses to information overload in an organization and to uncertainty in its environment. The organization may (1) modify its structure by acquiring surplus resources or by modifying its channels of communication, (2) modify its decision process to enhance the incremental nature of these processes, and (3) incorporate into the organization other organizational entities that have previously been a part of the environment. However, the establishment and implementation of a formal financial incentive system may also be viewed as an organizational response to information overload and uncertainty. The principal research issue here concerns the relationship between internal financial incentives as an organizational adaptation and the other three adaptations outlined above. Specifically, we need to examine the degree to which the adaptations are compatible, the extent to which they reinforce or detract from each other, and the relative advantages and disadvantages to the organizations of these adaptive

mechanisms.

In summary, the gaps in the literature reviewed here are essentially those identified in the Project proposal which gave rise to this survey. It is clear that the most pressing issue is a lack of empirical research to test hypotheses generated by this literature. The next step in our research effort will be to identify sources of data to meet this need.

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